European Commission

Support to the Circular Plastics Alliance in establishing a work plan to develop guidelines and standards on design-for-recycling of plastic products

Final report

Authors:

Watkins E., Romagnoli V., Kirhensteine I., Ruckley F., Kreißig J., Mitsios A., Pantzar M.

Editors:

Saveyn H., Garbarino E.

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Joint Research Centre

Contact information
Name: European Commission, Joint Research Centre, Growth & Innovation – Circular Economy & Industrial Leadership
Address: Edificio EXPO, Calle Inca Garcilaso 3, 41092 Seville, Spain
Email: jrc-env-research@ec.europa.eu
Tel.: +34 954 48 8318

EU Science Hub
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Contents

Foreword

This document has been prepared by the contractors for the study "Support to the Circular Plastics Alliance in establishing a work plan to develop guidelines and standards on design-for-recycling of plastic products", commissioned by the Joint Research Centre of the European Commission (contract no. 938401-2019 BE).

It summarises the findings of the work undertaken by the study team, led by the Institute for European Environmental Policy (IEEP) and also comprising Ramboll Environment & Health GmbH, Wood (Amec Foster Wheeler E&I GmbH) and Deloitte Conseil.

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Authors

Emma Watkins (IEEP)

Valentina Romagnoli (Ramboll)

Ilona Kirhensteine (Wood)

Fleur Ruckley (Wood)

Julius Kreißig (Wood)

Andreas Mitsios (Deloitte Conseil)

Mia Pantzar (IEEP)

Abstract

Based on data (from the years 2014-2018) included in this study's mass flow model, a current annual production of 3.8 million tonnes of recyclate is estimated for a set of identified priority products. This falls short of the EU target of 10 million tonnes of recycled plastics to be used annually in the EU by 2025.

An analysis of 25 industry-led design-for-recycling guidelines (24 for packaging and one for EEE) shows that: most provide a matrix or checklist with restrictions, requirements or targets for specific product features to increase recyclability; many use a three-choice classification system; and some provide a logo or label for compliance.

Key success factors for design-for-recycling guidelines include: holistic, transparent, precise and consistent guidelines developed in cooperation with the whole value chain; striking a balance between an EU-wide harmonised approach and respecting country specificities; and the use of certification or labels for products complying with guidelines.

It is recommended that the CPA contribute to establishing a holistic and harmonised approach to guideline development, including regular updating, an enhanced testing process and greater consistency and clarity. In parallel, the CPA should continue promoting the use of guidelines, to increase their uptake throughout the value chain.

Executive summary

E1 Supporting the Circular Plastics Alliance work plan on design-for-recycling guidelines

The Joint Research Centre of the European Commission contracted a study entitled "Support to the Circular Plastics Alliance in establishing a work plan to develop guidelines and standards on design-for-recycling of plastic products". The objective of the study was to provide **analytical support to the Circular Plastics Alliance (CPA) in preparing a work plan for the delivery of its design-for-recycling guidelines** and standards for plastic products. The CPA work plan should support improvements in the **recyclability of plastic products**, with the objective of ensuring that recycling plants in the EU are provided with enough feedstock for **10 million tonnes of recycled plastics to be used annually in the EU by 2025**.

E2 Priority plastic products or product groups

Under the first task of the study, a **list of priority plastic products or product groups** was established for each of five sectors: agriculture, packaging, electrical and electronic equipment (EEE), construction, and automotive. The process of selecting the priority products/product groups has been guided by the final **aim of reaching the 10 million tonnes target in the most rapid and advantageous way**, given the current situation and foreseeable developments in the near future; this translates into the principle of the so-called "low hanging fruit".

Table E.1. Selection of priority products/product groups

Polymer	Products/product groups
Packaging sector	
LDPE	Flexible packaging
PET	Bottles, trays
HDPE	Necked bottles (e.g. for milk and detergents)
PP	Food containers, caps and closures
PS	PS packaging (cups, trays, dairy packaging)
EEE sector	
PP	Dishwashers, dryers, food processing appliances, hot water appliances, vacuum cleaners
PS	Fridges
PUR	Cooling appliances

Polymer	Products/product groups
Agriculture sector	
LDPE	Mulching and silage films
HDPE	Nets (bale wraps and protections)
PP	Twines
Construction sector	
PVC	Window profiles, roller shutters, doors
HDPE	Pipes
EPS	Insulation
Automotive sector	
PP	Bumpers, body side, dashboards
PUR	Seats padding
PVC	Car interiors, cable covers

A dynamic **mass flow model** and **inter-sectoral Sankey diagram** were developed, **mapping the plastic material flows for each of the selected products**. The model maps the following **stages of material flows:** product waste generation; waste collected (to sorting); waste recycling; recyclate production; recyclate end-user sectors; amount of recyclate going to the end-user sector; and amount of recyclate coming from the source sector. The structure of the mass flow model is illustrated in the figure below.

Due to the misalignment of available data for different sectors, polymers and products, data ranging from the years 2014 to 2018 had to be considered for the calculations (although the project team is aware that relevant evolutions took place during these four years).

The figures provided therefore reflect the situation between 2014 and 2018 ("baseline"), hence they do not take into account possible improvements in the future due to better design-for-recycling of plastic products, which is a commitment of the CPA.

Based on the data currently included in the model, a **production of a total amount of recyclates equal to 3.8 million tonnes is calculated**.

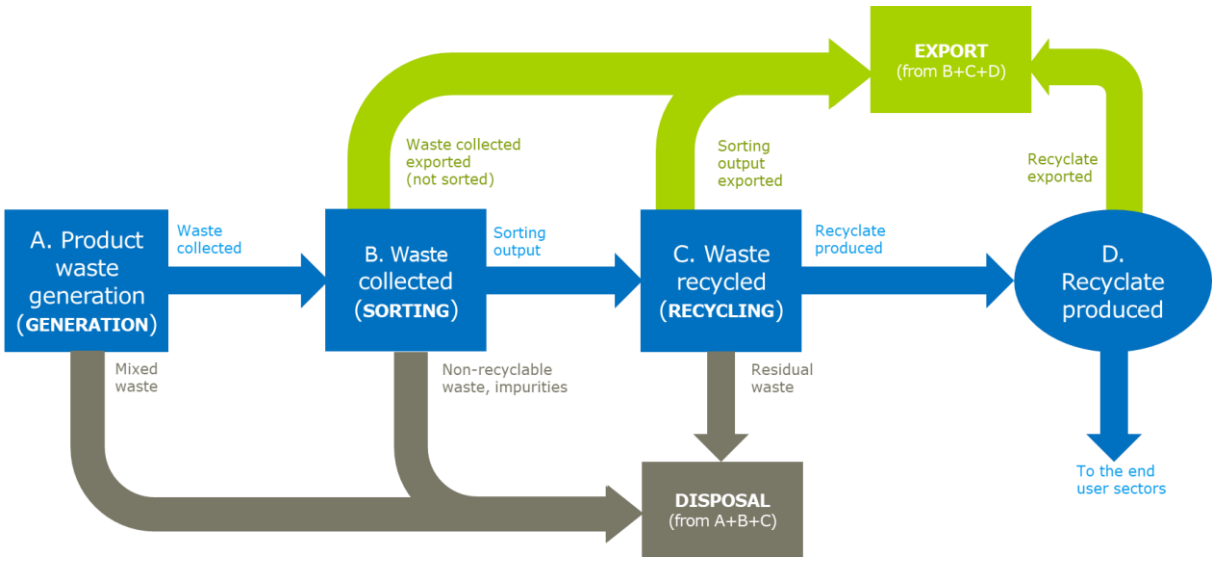
Relevant constraints and challenges have been encountered during the collection of data, in particular:

- General lack of publicly available data on specific products/product groups made of plastic or containing plastic components; and
- Very high variability in the reporting practices by different sources and heterogeneity of data, e.g. reporting years, data normalization, and data aggregation (by sector, polymer etc.).

The model has thus been designed so it can be easily updated by the CPA when new data becomes available.

Taking into account the above, it is expected that **the selection of priority products made within this study, complemented by the products added by the CPA during summer 2020 and a complete list of relevant products identified for the EEE sector** covering all categories of EEE products (e.g. consumer electronics, tools, screens etc.) **constitutes a very good basis for the achievement of the 10 million tonnes target by 2025**.

Figure E.1. Structure of the mass flow model



E3 Review of existing design-for-recycling guidelines, standards and tools

Many industry-led guidelines, supporting implementation tools and formal technical standards exist to support design-for-recycling. During the study, headline information was gathered and summarised on **108 individual guidelines, standards and tools** relevant to the priority products and groups identified. For the purposes of this study, **guidelines** are typically industry-developed documents providing broad guidance for producers on how to design products for recyclability. **Standards** are usually developed by international or national official standards bodies/agencies and contain precise technical detail on specific product design features. **Tools** are instruments (documents, websites, checklists etc.), often issued in conjunction with guidelines, to help producers to assess the level of recyclability of their products. More detailed information was then gathered on a **shortlist of 25 industry-led guidelines**, prioritised by the products, groups and polymers in scope, and their perceived effectiveness and market penetration/uptake (see chapter 3 of the report). This shortlist is shown below.

Table E.2. Shortlisted industry-led guidelines

1	10 codes of conduct for Design for Recyclability for Polyolefin Packaging Design (Borealis)	12	Design for recycling guidelines for PET thermoformed trays: Clear transparent to be recycled even in food applications (PETCORE Europe)
2	Circular Analytics guidelines	13	RECOUP guidelines (RECOUP)
3	Circular Packaging Design Guideline (FH Campus Wien)	14	Recyclability of plastic packaging: Eco-design for improved recycling (COTREP)
4	2020 rate list for recycling household packaging (Citeo)	15-22	RecyClass design for recycling guidelines (RecyClass and Plastics Recyclers Europe): — HDPE Coloured Containers — HDPE Natural Containers — PE Coloured Flexible film — PE Transparent Flexible film — PO Pots, Tubs, Blisters & Trays — PP Coloured Containers — PP Natural Containers — PP Transparent Natural Flexible film
5	cyclos-HTP (Institute cyclos-HTTP)		
6	Design 4recycling. Design plastic packaging so it can be recycled (Der Grüne Punkt)		
7	Design for Recycling Guidelines (SUEZ.circpack®)		
8	Design Guide for PET Bottle Recyclability (EFBW and UNESDA)		
9	Designing for a Circular Economy Guidelines (CEFLEX)	23	Recycled plastics - Practical guide for integrating recycled plastics into the electrical and electronic equipment (Eco-systemes)
10	European PET Bottle Platform initiative – EPBP (EPRO, EuPR, Petcore, UNESDA and EFBW)	24	Reuse and recycling of plastic packaging for private consumers (Network for Circular Plastic Packaging, on behalf of the Danish Plastics Federation)
11	Packaging 4 Recycling (EXPRA)	25	Round Table Eco Design of Plastics Packaging (IK Industrievereinigung Kunststoffverpackungen e.V)

E4 In-depth assessment of the 25 shortlisted guidelines: key findings

E4.1 Structure and content of the guidelines

— **Product types, product groups and polymers** in scope: Twenty-four of the guidelines apply to packaging and one to EEE. 68% apply to specific product types and 36% to product groups. Most are polymer specific (i.e. relate to one or multiple specific polymers). Of the most frequently covered polymers, 64% of the guidelines cover PP, 56% PET (or both), and 68% PE (including HDPE, LDPE).

— **Key focus or objective**: Besides focusing on product design, the guidelines also apply to other aspects across the plastics value chain, including waste collection, sorting and general recycling. Twelve focus on closed-loop recycling and five on specific end-use applications.

— **Approach and communication style**: Many (66%) of the guidelines provide a matrix or checklist to consider specific product features and/or polymer types that increase recyclability. Some include factsheet type approaches, case studies or good practice examples. Most (23) utilise specific indicators or categorisations along a spectrum to classify the degree of recyclability, typically using a three-choice classification system.

— **Technical features covered**: Over 75% of the guidelines define design characteristics related to common features such as colours and labels. More than half also consider resin or polymer type, additives and printing.

— **Minimum requirements, restrictions & targets**: Thirteen of the guidelines include some form of restriction regarding **material composition** and/or **specification** of particular features. Ten set minimum requirements to achieve full compatibility with the guideline. Some (7) identify and set targets, but the remainder do not.

— **Information and labelling requirements**: 14 of the guidelines provide or rely on the achievement of some form of logo or label. Seven do not (for 4, no information on labelling was available).

— **Regulatory obligations and economic incentives**: Eight of the guidelines explicitly relate to EU legislation, two to national legislation and two to both. One guideline aligns to the global sustainable development goals (SDGs). None of the guidelines make specific reference to economic incentives.

E4.2 Effectiveness of the guidelines:

— **Perceived effectiveness and achieved/achievable recycling rates**: Indications of effectiveness include: an 11% increase in lightweight materials recycled during a 2016 trial (the COTREP guideline Recyclability of plastic packaging: Eco-design for improved recycling); and a Europe-wide PET packaging recycling rate of around 50% - although it is not clear what proportion of this can be attributed directly to the guidelines. Although data is available on the recycling rates of products covered by the guidelines, it is generally difficult to attribute levels of recycling specifically to the application of the guidelines, since many other factors also influence recycling rates. Some guidelines refer to specific quantified targets, for example: the Danish Plastics Federation is working towards a recycling rate of 60% (by 2025) for both rPET of food grade quality and PP and PE for non-food packaging (plastic packaging recycling in Denmark currently stands at 18%); the COTREP guideline has targets to increase recycling rates as follows (from 2016-2030) – bottles 55% to 82%, pots, trays and other rigid packaging 1% to 55%, and film 1% to 23%; the CEFLEX guidelines aim for over 80% of collected flexible plastic packaging to replace virgin materials; and PETCORE Europe has pledged to achieve an average use of 70% recycled PET for sheets and trays, representing use of around 2.07m tonnes recycled PET per year, by 2025 (compared to 1.23m tonnes in 2017).

— **Market penetration/uptake**: Information on percentage market share was not available, however the following indications were identified: EXPRA members' compliance schemes in 17 EU Member States are currently working towards the Packaging 4 Recycling guideline's objectives; the RecyClass online platform/tool is used by over 2,500 product designers in Europe and the US, with around 550 product analyses currently performed each month; the vast majority of PET bottles on the European market now meet the European PET Bottle Platform initiative (EPBP) guidelines; since the launch of the CEFLEX guidelines in June 2020, 360 registrations were received to access the guidelines; and Cyclos-HTP and Der Grüne Punkt have made approximately 2,500 packaging analyses and certifications since 2014.

— **Costs of implementation**: The implementation costs of the guidelines vary. They may include membership fees (sometimes at different levels), fees to access the guidelines, fees to certify products, costs for laboratory testing of products, and broader costs related to ensuring products comply with the guidelines. Comprehensive data to assess total costs and percentage cost breakdown for the different actors involved was not available. However, in general, costs are borne mostly by guideline users (i.e. producers of items) and to some extent by members of the issuing bodies. Little information was received regarding potential benefits of the guidelines, but in principle benefits could accrue to society as a whole (from increased recycling), but also for instance to recyclers (more high quality feedstock) or producers (e.g. reputational benefits, EPR savings).

A number of **barriers/challenges and success factors** have been identified for the implementation of guidelines:

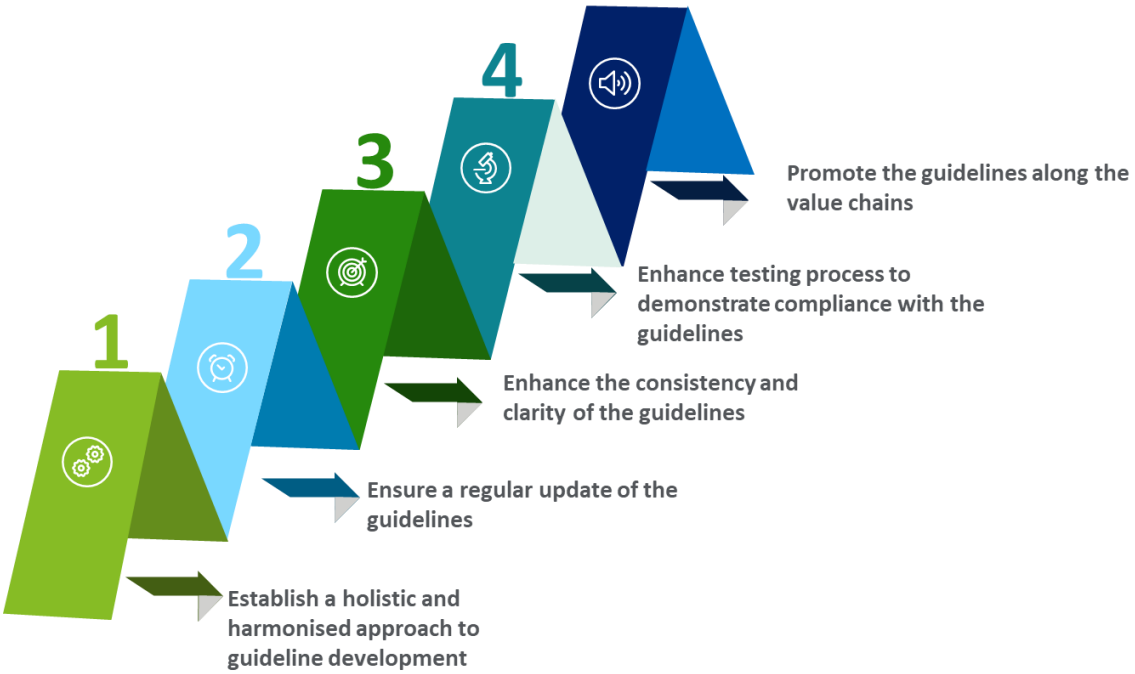
— **Barriers/challenges to implementation**: Potential barriers identified include: applicability only in specific national contexts as opposed to applicability to the whole EU market; lack of transparency, precision and consistency in the criteria used to assess recyclability; in some cases, lack of detailed technical specifications; in some cases, incompatibility of product functionality and (full) recyclability; lack of guidelines for the use of recycled polymers within certain applications; lack of suitable recycling plants in Europe to conduct pilot testing of practical recyclability; and in some cases, inadequate performance of current collection and recycling infrastructure/systems, and the cost of improving them.

— **Best practice/success factors for implementation**: Success factors identified include: Taking a holistic and EU-harmonised approach to guideline development; involvement and commitment of the whole value chain; systematic, harmonised information on recycled content; regular updating of guidelines; ensuring that guidelines are clear, concise and easy to follow; provision of a publicly accessible methodology upon which the guidelines were based; inclusion of general design criteria plus polymer/product specific criteria; development of guidelines for disruptive technologies where pilots with promising results exist; and provision of simple, and free, self-assessment tools, protocols, certification or labels.

E5 Recommendations for a future CPA work plan for design-for-recycling guidelines

The study team have developed a list of five key recommendations for the CPA to consider when drafting its work plan for design-for-recycling guidelines. The recommendations relate to the removal of barriers, and creation or reinforcement of drivers, to achieve increased effectiveness of guidelines, as well as more generally the improvement of the performance of waste management across the whole value chain. The recommendations are outlined in the figure below, and discussed in detail in chapter 5 of the report).

Figure E.2. Overview of recommendations



E6 Additional issues for future work and research by the CPA

Further to the recommendations above, the study team identified a number of additional issues which the CPA may wish to consider in its future work on design-for-recycling. These include:

- **Addition of further data to the mass flow model**, including on additional priority products.
- In line with the commitment of the CPA in their declaration of September 2019([1]), it is essential that the CPA develops **standards which facilitate the integration of recycled content** in priority products, and help make the link between design-for-recycling and the integration of recycled content.
- Gathering of **additional information on the market share/penetration of existing design-for-recycling guidelines**.
- An additional **review of the effectiveness of the guidelines**, in particular to judge their contribution to the 10 million tonnes target, once the guidelines have been in place for a significant period of time and more data is available. This could usefully include further investigation of the **relative importance of the identified driving factors** or barriers to success.
- An investigation of the **appropriate balance between the effectiveness of guidelines and the costs** related to their implementation.
- An assessment of existing capacity, and identification of the need for additional capacity and investment, for conducting **pilot testing of the practical recyclability of products in recycling plants**.

[1] https://ec.europa.eu/docsroom/documents/36361

1 Introduction to the study and this report

This document constitutes the final report of the study "Support to the Circular Plastics Alliance in establishing a work plan to develop guidelines and standards on design-for-recycling of plastic products", commissioned by the Joint Research Centre of the European Commission.

The objective of the study is to provide **support to the Circular Plastics Alliance (CPA) in preparing a work plan for the delivery of its design-for-recycling guidelines** and standards for plastic products. The CPA work plan should support improvements in the **recyclability of plastic products**, with the objective of ensuring that recycling plants in the EU are provided with enough feedstock for **10 million tonnes of recycled plastics to be used annually in the EU by 2025**.

It should be noted that the study did not aim to develop actual guidelines for the CPA, but rather to provide the CPA with useful information for their ongoing work on guideline development. **Full ownership of the work plan and its development therefore remains with the CPA**.

Task 1 of the study was to establish a **list of priority plastic products or product groups**. Quantitative and qualitative data was gathering by polymer and sector, and through an iterative process a set of priority products was selected which was deemed to have the greatest potential, by 2025, to contribute to the 10 million tonnes target. In addition, a dynamic **mass flow model** and **inter-sectoral Sankey diagram** were developed, based on data on plastic waste generation, collection, recycling, recyclate production and use. The findings of Task 1 are presented in Chapter 2, the mass flow model in Annex 1, and the Sankey diagram in Annex 2.

Task 2 mapped existing design-for-recycling guidelines, standards and tools relevant to the design-for-recycling of the priority plastic products/groups. Firstly, broad information was gathered on a set of 108 relevant guidelines, standards and tools. Then more detailed information was gathered on a **selected shortlist of 25 industry-led guidelines**. The work undertaken in Task 2 is summarised in Chapter 3, and the information gathered on both the shortlist and the longlist of guidelines, standards in tools is provided in Annex 3.

Task 3 undertook an **assessment on the 25 shortlisted industry-led guidelines**. This includes an analysis of the commonalities and differences between the guidelines, a review of their effectiveness, and an analysis of driving factors behind their success. The results of Task 3 are presented in Chapter 4.

Task 4 saw the **development of recommendations for the CPA** to consider during the development of its work plan for design-for-recycling guidelines. The study team's recommendations are presented under two main headings, those that related to the guidelines themselves, and those related to external factors that may have an impact on the guidelines' effectiveness. These recommendations are presented in Chapter 5.

Finally, **Task 5** was an overarching task to ensure **adequate and regular consultation with the CPA** throughout the study. This included regular contact (e.g. through interviews and questionnaires) with the Thematic Coordinators for Design (henceforth Design Coordinators) of the CPA. In particular, the Design Coordinators were given the opportunity to feed into the development of the list of priority products and groups, to provide feedback on the proposed shortlist of guidelines, and to contribute to the development of the study's recommendations. Two webinars were held (in December 2019 and May 2020) to discuss the study and its draft findings with selected CPA signatories. In addition, the issuing bodies of the shortlisted guidelines were contacted via a written questionnaire, to feed in to the assessment of the guidelines. The results of these consultation processes are integrated into Chapters 2-5 of this report, the questionnaire to issuing bodies is included in Annex 4, and a list of organisations contacted during the study is provided in Annex 5.

2 Establishing a list of priority plastic products or product groups (Task 1)

The objective of Task 1 was to establish a **list of priority plastic products or groups** to support the CPA in developing, revising or updating guidelines and standards regarding design-for-recycling. It also aimed to evaluate whether the proposed list of priority plastic products/product groups is suitable to ensure that EU recycling plants have the necessary feedstock to at least meet the target of 10 million tonnes of recycled plastics used to produce new products in the EU market, as set out in the Pledging Campaign launched under the Plastics Strategy, Annex III, and endorsed by the CPA. The Task further envisages a selection of additional products/product groups that could be added to the list in order to reach or exceed the target of 10 million tonnes of recycled plastics.

The methodology used for the implementation of this Task was based on the following steps:

1. Selection of the main polymers and sectors for data gathering
2. Quantitative and qualitative data gathering by polymer and sector
3. First selection of priority products and construction of a dynamic mass flow model including all relevant sectors and polymers identified, and development of an inter-sectoral Sankey diagram
4. Ongoing adjustment of the mass flow model (e.g. closure of data gaps, inclusion of additional products)

In parallel with the above-mentioned steps, a constant consultation and exchange with the CPA Design Coordinators and CPA signatories was performed, to collect information, close data gaps and ensure that the experience and knowledge of the CPA and its signatories were used to the optimum. In particular, individual calls were carried out at an early stage of this Task with the five CPA Design Coordinators in order to close data gaps and collect additional information on the selected polymers and sectors, and an online workshop was held on 27 May 2020 to present the results of this Task to CPA signatories.

The priority polymers and products/product groups selected are reported in Table 2.1 below.

Please note that the CPA's Design Work Plan is a living document, continuously updated by the Signatories to reflect work progress. Several priority product categories were further added to the list in the CPA Design Work Plan during the summer of 2020, such as PP Flexible Packaging, EPS Packaging or PVC pipes, flooring, films and sheets. This report does not take these into account as they happened after the final feedback round was closed.

Table 2.1. Selection of priority products/product groups

Polymer	Products/product groups
Agriculture sector	
LDPE	Mulching and silage films
HDPE	Nets (bale wraps and protections)
PP	Twines
Packaging sector	
LDPE	Flexible packaging
PET	Bottles, trays
HDPE	Necked bottles (e.g. for milk and detergents)
PP	Food containers, caps and closures
PS	PS packaging (cups, trays, dairy packaging)
EEE sector[2]	
PP	Dishwashers, dryers, food processing appliances, hot water appliances, vacuum cleaners

[2] Insufficient data or information were found to allow for a final selection of priority products covering the whole sector. Therefore, priority products for the EEE sector were selected based on data provided in [Ceced 2018] and concern only the "home appliances" category.

Polymer	Products/product groups
PS	Fridges
PUR	Cooling appliances
Construction sector	
PVC	Window profiles, roller shutters, doors
HDPE	Pipes
EPS	Insulation
Automotive sector	
PP	Bumpers, body side, dashboards
PUR	Seats padding
PVC	Car interiors, cable covers

2.1 Methodology and results

2.1.1 Selection of the main polymers and sectors for data gathering

The **selection of the main polymers** for the focus of quantitative and qualitative information collection was **based on the popularity of use and availability of data** of the different polymers in the identified sources, such as annual Plastics Europe reports, the database for the classification of the voluntary pledges([3]) under the Plastics Strategy and the study by Kawecki et al. (2018) "Probabilistic Material Flow Analysis of seven commodity plastics in Europe".

In particular, comprehensive research on how plastics are defined as a material in general and more specifically as final products has been performed to **identify the most common types of plastics** to be examined in more detail in a dedicated spreadsheet, which intends to provide an overview of the plastic material and recycling market.

The main polymers identified in this first step are:

- HDPE - high-density polyethylene
- LDPE - low-density polyethylene
- PET - polyethylene terephthalate
- PP - polypropylene
- PVC - polyvinyl chloride
- PS - polystyrene
- EPS - expanded polystyrene

The selection of the sectors was driven by the current structure of the CPA's sectoral working groups, to allow for an easier data gathering and information exchange process. Therefore, **the study focuses on the following five sectors**:

1. Agriculture
2. Packaging
3. Building and Construction
4. Electric and Electronic Equipment (EEE)
5. Automotive

[3] https://circulareconomy.europa.eu/platform/en/commitments/pledges

It is important to highlight that the selection of the above-listed five sectors **does not imply the exclusion from the mass flow model of the flows going to and stemming from other sectors**. These flows are taken into consideration and mapped whenever possible, depending on the availability of data, in an aggregated form.

2.1.2 Screening of voluntary pledges

As a preliminary step in the collection of information the project team performed a screening and general **analysis of the voluntary pledges** published on the Circular Economy Stakeholder Platform.

*It should be noted that **not all voluntary pledges are published** on the Circular Economy Stakeholder Platform, which is a major limitation to the present analysis. Only 46 of the 70 pledges submitted to the European Commission in 2018 could thus be analysed. A complete assessment of the 70 pledges was conducted by the European Commission in March 2019([4]).*

Most of the 46 pledges published[5] (out of 70 pledges submitted to the European Commission) **focus on the supply of recyclate to the market (mostly PET and LDPE), overall exceeding the 10 million tonnes target**. However, as reported in the Commission's Assessment Report on the pledges published in March 2019[6], the **commitments on the absorption of higher quantities of recyclate into new products are lower**, with an overall commitment of increasing the use of recyclate in products to around **6.4 million tonnes by 2025**.

Besides, many pledges have been set out under a series of preconditions, which are summarised as follows in the Commission's report assessment:

- Market conditions, in particular the availability of recyclates in sufficient quantity and quality;
- Greater collection and sorting of plastic waste, i.e. more plastic waste collected and better quality of sorted plastic waste;
- Increased recyclability of plastic products

It should be noted that the Circular Plastics Alliance, launched after the 2018 pledging campaign, aims at improving the above-mentioned conditions (cf. declaration of the Circular Plastics Alliance of September 2019[7]).

The assessment of the pledges makes it clear that there is a strong willingness from **recyclates end-using sectors to increase the amount of recycled plastics used** in their products, but this will happen **only if some key conditions are met**. The development of standards and guidelines is instrumental to improve the current conditions, and is mentioned in the declaration of the Circular Plastics Alliance, as regards in particular on: 1) design-for-recycling of plastic products; 2) quality of sorted plastic waste; and 3) quality of recyclates and recycling.

[4] Staff Working Document SWD(2019)92 final, available at: https://ec.europa.eu/docsroom/documents/34267
[5] Status at January 2020
[6] Staff Working Document SWD(2019)92 final, available at: https://ec.europa.eu/docsroom/documents/34267
[7] https://ec.europa.eu/docsroom/documents/36361

2.1.3 Data collection on polymers and sectors

The collection of quantitative and qualitative information on the identified sectors and polymers has been performed by means of desk research and direct consultation with CPA Design Coordinators and signatories.

The information sources analysed comprise legal documents, databases, reports from significant international organizations, and selected scientific papers.

All information gathered from the different sources has been compiled in an aggregated way on the main polymers identified and, when possible, in detail by sector. The **data gathering has been focused on the topics listed in** Table 2.2 **below and the data collected range from year 2014 to year 2018,** depending on the availability of data.

Table 2.2. Data gathered for selected polymers and sectors

General
Alternative name(s) used in literature and by the industry
General remarks
Relevant products/product groups
Relevant sectors
Waste and recycling/recyclability
Waste generation in EU (t/y)
Recyclability
Recycling rate (%)
Market share
Virgin material market share (%)
Recycled material market share (%)
Virgin material consumption (t/y)
Recycled material consumption (t/y)
Plastic converter demand (%, t/y)
Obstacles to recycling/recyclability
Key obstacles to greater recyclability of the products
Key obstacles to higher recycling rates
Substances and contaminants hampering the recycling process
Role of additives in the plastics converting process
Technology and innovation
Type of recycling (closed loop/ open loop)
Available cost-efficient innovations
Measures to increase amount of collected material and/or quality of collected material

The spreadsheet was used to produce a first draft of plastic material flow charts for each sector, which was shared with some CPA signatories and discussed with the Design Coordinators of the 5 sectoral Working Groups of the CPA during guided individual calls.

2.1.4 Selection of priority products and construction of a mass flow model

The process of selecting the priority products/product groups has been guided by the final **aim of reaching the 10 million tonnes target in the most rapid and advantageous way**, given the current situation and the foreseeable developments in the near future; this translates into the principle of the so-called "low hanging fruit". The construction of the mass flow model and the selection of the priority products have been approached as an iterative process, in which the results from the desk research and the feedback received

from the Design Coordinators and some CPA signatories have been combined and confronted with the following **key eligibility criteria**:

- High polymer and product waste generation
- High recyclates production
- The product is technically or practically recyclable ([8]) and has a high potential for increasing the recycling rate in the future, in particular through DfR guidelines and standards
- The product has a high potential for absorbing a higher amount of recyclates
- The identified bottlenecks in the mass flow model can be successfully addressed, especially by means of revision or development of DfR guidelines and standards

The integrated and "open" approach has been chosen over a systematic multi-level assessment due not only to the very broad range of plastic products on the market and the often qualitative factors to be taken into consideration for the final selection, but mostly due to a general lack of comparable information (quantitative and qualitative). The most relevant constraints and challenges encountered during the collection of data can be summarized in the following points:

- General lack of publicly available data on specific products/product groups made of plastic or containing plastic components
- Very high variability in the reporting practices by different sources and heterogeneity of data, e.g. reporting years, data normalization, data aggregation (by sector, polymer etc.)

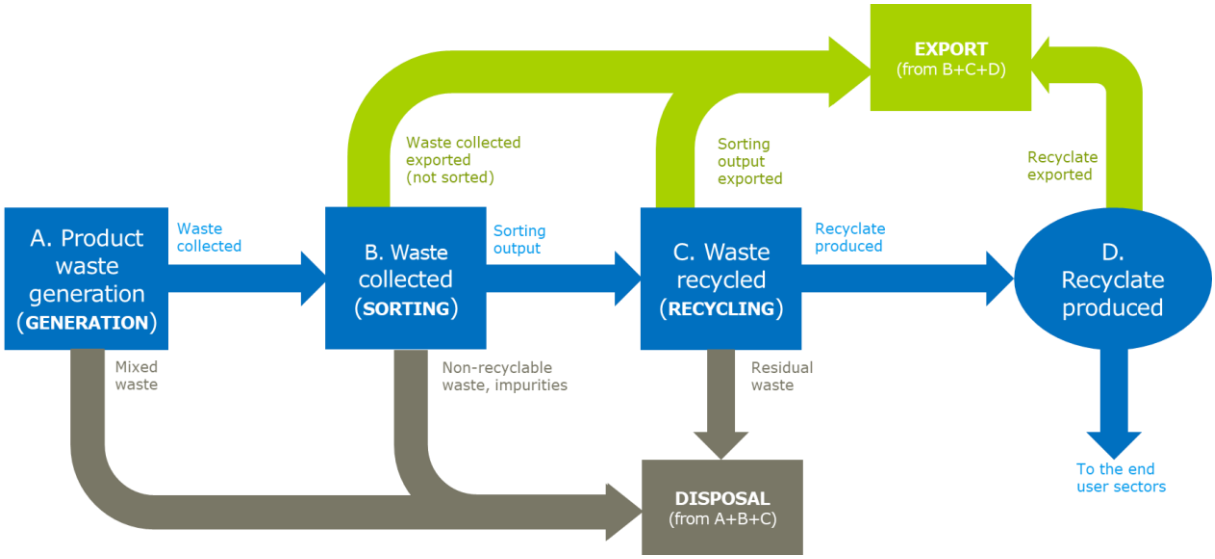
Based on the approach described above, **a selection of 28 products/product groups has been made**. The **mass flow model** has been developed in order **to map the plastic materials flows for each of the selected products**, from product waste generation to the production of recyclate. The starting point of the mass flow model is therefore the product waste generation, and the final point is the connection of the recyclate produced from a specific product to the respective end-user sector. The model also addresses the **second life of the plastic materials**, linking the production of recyclate for each of the five sectors to the corresponding end-user sector. The mapping of the relations between first and second life plays a fundamental role in the work of the CPA on the revision/development of DfR guidelines: closed-loop (product to product or sector to sector) recycling is important to the overall market balance, to avoid a possible saturation of those markets that will absorb recyclates originating from other sectors (open loops).

The following stages of the plastic material flows are mapped by the model (see Figure 2.1 below):

- **Product waste generation**: How much plastic waste is generated by the product? The product waste generated is calculated taking into account the share of polymer contained in the product;
- **Waste collected (to sorting)**: How much plastic waste is collected and goes to sorting? This stage considers the share of product waste (only the plastic part) that is separately collected;
- **Waste recycling**: How much plastic waste goes to recycling facilities? This stage considers the amount of product waste (only the plastic part) that, after being sorted, is sent to recycling;
- **Recyclate production**: How much recyclate is eventually produced? Based on the recycling process efficiency, the final production of recyclate is calculated;
- **Recyclate end-user sectors**: To which sectors does the recyclate go? The end-user sectors for the polymer recyclate produced are identified;
- **Amount of recyclate going to the end-user sector**: How much of the recyclate produced goes to the identified end-user sector? The amount of polymer recyclate produced by a sector is then split into various flows going to the different end-user sectors identified;
- **Amount of recyclate coming from the source sector**: How much of the recyclate used in the product comes from the identified source sector? As a final data cross-check, the amount of recyclate used by a sector is split into various flows going to the different source sectors.

[8] In this study, a plastic product is considered technically recyclable if the recycling technology is available. A product is defined as practically recyclable when an adequate and economically sound system for the collection, sorting, recycling and reuse of the recyclate for the production of new products is in place.

Figure 2.1. Structure of the mass flow model



Based on the data currently included in the model, a **current annual production of a total amount of recyclate equal to 3.8 million tonnes is estimated**([9]).

In order to be able to estimate the production of recyclate from the selected priority products and due to the misalignment of available data for different sectors, polymers and products, data ranging from year 2014 to 2018 had to be considered for the calculation (although the project team is aware that relevant evolutions took place during these four years). Due to the dynamic structure of the model, this result will be automatically updated, and the reliability of the above reported figure will increase, when new and better-quality data are added to the model by the CPA in the future.

It is interesting to observe that the above reported production of recyclate calculated with the mass flow model is in line with the overall demand for recycled plastics of 3.9 million tonnes, calculated for 2016 in the Commission's Assessment Report of the pledges of March 2019([10]).

A full assessment of whether the selected priority products will be sufficient to ensure that recycling plants in Europe have the necessary feedstock to reach the 10 million tonnes target by 2025 is not feasible at this stage, due to the lack of sufficient comparable data and reliable estimations of future trends. Nevertheless, the information and data collected throughout this first part of the study indicate that the right path for achieving this objective is to focus not only on improving the design-for-recycling of the products, but also to address the challenges that exist in the different stages of the plastic materials value chain in a comprehensive way, and to address the main bottlenecks in the recycling potential of different products at the stage where an intervention would be most efficient and effective in terms of short-term outcome.

For instance, the priority products identified for the **agriculture** sector, even if contributing with high amounts to the recyclate produced within the sector, do not currently seem to have a very high DfR potential. The main existing challenges such as the contamination of the products with soilage and the lack of collection schemes refer in fact to different stages of the product value chain and need to be addressed by improving collection, and introducing new technologies for the pre-treatment of waste that allow for efficient soil removal whilst maintaining the quality and value of the plastic material.

In the **packaging** sector, design-for-recycling instead represents a crucial stage with a very high potential to increase the amount of recyclate available in the future. A key challenge to the greater production of recyclates from packaging waste can be addressed through better design-for-recycling, starting with the priority products identified in the present study. Increasing collection for recycling and standardising the quality of sorted plastic waste are equally necessary to ensure recyclables get effectively recycled.

[9] Due to current lack of data, the reported amount does not include contributions from all the selected products.
[10] Staff Working Document SWD(2019)92 final, available at: https://ec.europa.eu/docsroom/documents/34267

Design-for-recycling also has great potential in the **EEE** sector. As reported in (Trinomics, 2020), design for disassembly constitutes an important technical enabler of WEEE recycling, with plastic being the second largest material fraction of waste generated.

As regards the **construction** sector, DfR has the potential to improve recyclate quality, and therefore to trigger the uptake and hence the supply of recyclate in the future. The increase in the production of recyclate from this sector in the coming years is also considered to be tightly bound to the trend of the renovation ratio: if this ratio is improved, then a higher amount of post-consumer waste would be available, thus increasing the potential for use of recyclate in new products. This however also implies an improvement of the collection of construction plastic waste, including separate collection during demolition.

The **automotive** sector is considered to have a high potential for increasing the production and quality of recyclate by improving DfR. DfR could indeed help address challenges such as the high quality requirements for recyclate to be used in the automotive industry, the use of additives and of multiple materials.

On the basis of these considerations, it is expected that **the selection of priority products made within this study, complemented by the products added by the CPA during summer 2020 and a complete list of relevant products identified for the EEE sector** covering all categories of EEE products (e.g. consumer electronics, tools, screens etc.) **constitutes a very good basis for the achievement of the 10 million tonnes target by 2025**.

2.1.5 Considerations for next steps

For some sectors, the **identification of priority products** was problematic for various reasons. In the **automotive sector** for instance, priority products might be composed of different polymers, whose specific quantities are hard to estimate and to further allocate to the different stages of the waste management chain. For this sector, relevant products (e.g. high plastic content products) have been identified, but the flows of the different polymers throughout the waste management chain cannot easily be mapped due to the current practice of shredding end-of-life vehicles (ELV) into automotive shredder residue (ASR), in most cases without proper upstream dismantling. Nevertheless, the identification of priority products remains relevant in order to support the future improvement in design-for-recycling and the development of new technologies (or the wider diffusion of already existing ones) for the efficient separation of plastic parts and subsequent high-quality recycling. ASR post-treatment technologies (PTT) do already exist that allow for a good recovery of plastic from ASR. However, the identification at an early design phase of priority products on which to focus efforts for improved recycling potential is crucial for supporting vehicle dismantling before shredding, to increase both the amount and the quality of the recyclates. In the **EEE sector**, due to the lack of data on EEE products, the focus could be shifted from priority products to priority parts of products, where more data are available.

The information and data provided in this report only refer to the analysis performed until end of May 2020, as additional information on priority products has been received from the signatories of the CPA after closure of the final feedback round.

As a next step, the CPA intends to include further information and data to the mass flow model and a **second list of relevant products/product groups that will help to reach the 10 million tonnes target ("second wave").** This could be included in the model at a later stage by the CPA. Due to the lack of data for some of the already selected products, a selection of further products was not feasible during the course of this study. Data on additional relevant priority products are currently being collected by the CPA signatories. With this in mind, the mass flow model has been constructed as a versatile and user-friendly tool that will allow for easy and agile updating, and inclusion of additional priority products in the future.

3 Mapping existing design-for-recycling guidelines, standards and tools (Task 2)

The objective of Task 2 was to **map and scope existing design-for-recycling guidelines, standards and tools** relevant to the list of priority plastic products and product groups identified in Task 1. Within Task 2, **information was gathered on specific aspects and features of the identified guidelines, standards and tools** in a two-stage process.

For the purposes of this study, **guidelines** are defined as documents (often industry-developed), that provide guidance for producers on how to design products for recyclability, providing broad parameters for specific design features to indicate the level of recyclability. **Standards** are defined as documents (usually developed by international or national official standards bodies/agencies) that contain precise and technical details on specific product design features. **Tools** are defined as instruments (documents, websites, checklists etc.), often issued in conjunction with guidelines, that can help producers to assess the level of recyclability of their products against specific design criteria.

The methodology used for the implementation of this Task was based on the following steps:

1. Determination of criteria to analyse commonalities, differences and effectiveness of guidelines and standards
2. Scoping and shortlisting of guidelines and standards
3. Additional information gathering on 25 shortlisted guidelines

In addition to these steps carried out by the study team, the Design Coordinators of the CPA were given the opportunity to comment on the team's proposed shortlist prior to the additional information gathering phase.

3.1 Methodology and results

3.1.1 Determination of criteria to analyse commonalities, differences and effectiveness of guidelines, standards and tools

During the inception phase of the study, the team identified **a set of criteria about which information would be gathered** on the identified guidelines, standards and tools. This was further refined as the work progressed, to respond to requests from the CPA's Design Coordinators for information on some additional aspects of the guidelines, standards and tools (notably the methodology used for developing industry-led guidelines).

To ensure an efficient scoping exercise, a first set of criteria were identified for the team to map a longlist of guidelines, standards and tools, and a second set of criteria were identified for additional information gathering on an agreed shortlist of 25 guidelines. The criteria are outlined in Table 3.1 below.

Table 3.1. Criteria for data gathering on existing design-for-recycling guidelines, standards and tools

Criterion	Explanation
First phase criteria – for full longlist of identified guidelines, standards and tools	
Name of guideline, standard or tool	Full title of guideline/ standard/ tool
Guideline, formal standard or tool?	Is the item: a technical/ formal standard; an industry-led guideline; or a tool to help implement a standard/ guideline?
Issuing body (name)	
Issuing body (type)	e.g. EPR scheme, producer (individual), producer (association), standards body (international), standards body (national), value-chain platform, other
Year issued	
Key focus/objective	e.g. design for closed-loop recycling, design for open-loop recycling, sorting, use of recyclates in specific end-use application, other

Main relevant CPA working group	i.e. Agriculture, Automotive, Construction, EEE or Packaging
Other relevant CPA working groups	i.e. Agriculture, Automotive, Construction, EEE or Packaging
Products/groups in scope	e.g. bottles, trays, films, containers, all packaging, EEE, agricultural plastics etc.
Polymers in scope	e.g. PP, PS/EPS, PVC, PET, LDPE, HDPE, PE, other
Perceived effectiveness: information	Any identified qualitative or quantitative information to indicate actual or potential contribution to achieving high recycling rates
Perceived effectiveness: initial estimate	Initial estimate of perceived effectiveness based on expert judgement: scale of 1 (high) to 3 (low)
Market penetration/ uptake: information	Any identified qualitative or quantitative information to indicate extent of implementation by actors in the value chain
Market penetration/ uptake: initial estimate	Initial estimate of perceived market penetration/uptake based on expert judgement: scale of 1 (high) to 3 (low)
Validation requirements	e.g. self-assessment, validation by issuing body or 3rd party validation
Information source(s)	Links to key sources of information
Second phase criteria – for agreed shortlist of industry-led guidelines	
Definitions/ indicators	How is compliance with the guideline defined? Are specific indicators/ categorisations used (e.g. high/ medium/ low recyclability)?
Technical features covered	Specific design features addressed by the guideline e.g. polymers/resins, colours, inks, labels, direct printing, additives, adhesives, closures/seals, lids, liners, valves, recycled content etc.
Minimum requirements/ restrictions/ targets	Any specific requirements/ targets in the guideline e.g. prohibited features, min/max levels of additives etc.
Information/ labelling requirements	Any associated information/ labelling requirements e.g. Green Dot, QR-code, laser (micro-marking), molecular markers, block chain etc.
Methodology for developing the guideline	Brief description of methodology, evidence/ research used, who developed the guideline, how it is revised etc.
Test protocol/ compliance check	Test protocols or compliance checks used to apply the guidance e.g. random material analysis, sampling
Regulatory obligations/ economic incentives	Does the guideline refer to or help to implement any specific regulatory requirements e.g. targets in EU legislation, impact on price/ purchase volume, eco-modulation within EPR
Total cost and cost breakdown for actors	e.g. membership fees, certification fees, testing costs, compliance costs (e.g. €/tonne to comply with technical requirements of the Guideline), other costs
Material flows	e.g. volume of products/ polymers designed based on the guideline, volume collected/ sorted, outputs of recycling plants, end use applications, loss rate from collection/ sorting/ reprocessing
Recycling rates achieved/ achievable	e.g. data on % rate of recycling (or other indicators) achieved/achievable through implementation of guideline
Barriers/ Challenges to implementation	Any information identified on challenges of implementing the guideline
Best practice/ success factors	Any information identified on potential best practice elements/ success factors for the guidance
Additional information source(s)	Links to key sources of information

*The highlighted criteria in the table were used to select the shortlist for further information gathering

3.1.2 Scoping and shortlisting of guidelines, standards and tools

In the second step of this Task, a range of information sources (including international and regional standards bodies, producers/manufacturers, industry associations, EPR systems, academic and scientific publications, and broader online searches) were consulted to identify relevant guidelines, standards and tools. Information on the first phase criteria (see Table 3.1) was gathered for a total of **108 individual guidelines, standards and tools** and recorded in an Excel spreadsheet format (see Annex 3).

The key highlighted criteria outlined in Table 3.1 above (i.e. products/groups in scope, polymers in scope, perceived effectiveness, and market penetration/uptake) were given particular importance in defining the shortlist of guidelines and standards for the additional information gathering phase. Regarding the products/groups and polymers in scope, it was ensured that **each guideline, standard or tool proposed for the shortlist was relevant for at least one priority product/group and at least one priority polymer**. **Regarding perceived effectiveness and market penetration, relatively limited concrete information was found.** However, the study team made their best judgement on the actual or potential effectiveness and market penetration, based on information such as: recycling rates achieved, numbers of products adhering to the guideline, the number and market share of producers/manufacturers affiliated to the guideline's issuing body, and actions of the issuing body to support the application of the guideline (such as the provision of training or consultancy services related to the guideline).

Following the initial scoping exercise, the study team proposed **an intermediate list of 35 guidelines and standards**. Following discussion with the JRC and the CPA Design Coordinators, it was decided that **only industry-led guidelines would be selected for the shortlist**. This was to ensure that the most relevant elements of guidelines could be identified for use by the CPA in its future work on developing its own guidelines.

Following further discussion within the team and feedback from CPA Design Coordinators, the shortlist of 25 guidelines shown in Table 3.2 was selected for further analysis.

Table 3.2. Shortlist of 25 guidelines selected for further analysis

Name of guideline	Issuing body
Borealis 10 codes of conduct for Design for Recyclability for Polyolefin Packaging Design	Borealis
https://circularanalytics.com	Circular Analytics
Circular Packaging Design Guideline	FH Campus Wien; Section of Packaging and Resource Management
Citeo 2020 rate list for recycling household packaging	Citeo (France)
cyclos-HTP	Institute cyclos-HTTP
Design 4recycling. Design plastic packaging so it can be recycled	Der Grüne Punkt
Design for Recycling Guidelines	SUEZ.circpack®
Design Guide for PET Bottle Recyclability	EFBW (European Federation of Bottled Waters) and UNESDA (Union of European Beverages Associations)
Designing for a Circular Economy Guidelines (draft)	CEFLEX
European PET Bottle Platform initiative (EPBP)	European Association of Plastics Recycling and Recovery Organisations (EPRO), European Plastics Recyclers (EuPR), PET Containers Recycling Europe (Petcore), Union of European Beverages Association (UNESDA), European Federation of Bottled Water (EFBW)
Packaging 4 Recycling	EXPRA's Sustainability and Packaging Working Group
PETCORE Europe Design for recycling guidelines for PET thermoformed trays: Clear transparent to be recycled even in food applications	PETCORE (PET COntainers REcycling) Europe
RECOUP	Recycling of Used Plastics Limited (RECOUP)
Recyclability of plastic packaging: Eco-design for improved recycling	COTREP (Comite Technique pour le Recyclage des Emballages Plastiques), France
RecyClass design for recycling guideline for HDPE Coloured Containers	RecyClass / Plastics Recyclers Europe (PRE)
RecyClass design for recycling guideline for HDPE Natural Containers	RecyClass / Plastics Recyclers Europe (PRE)
RecyClass design for recycling guideline for PE Coloured Flexible film	RecyClass / Plastics Recyclers Europe (PRE)
RecyClass design for recycling guideline for	RecyClass / Plastics Recyclers Europe (PRE)

Name of guideline	Issuing body
PE Transparent Flexible film	
RecyClass design for recycling guideline for PO Pots, Tubs, Blisters & Tray	RecyClass / Plastics Recyclers Europe (PRE)
RecyClass design for recycling guideline for PP Coloured Containers	RecyClass / Plastics Recyclers Europe (PRE)
RecyClass design for recycling guideline for PP Natural Containers	RecyClass / Plastics Recyclers Europe (PRE)
RecyClass design for recycling guideline for PP Transparent Natural Flexible film	RecyClass / Plastics Recyclers Europe (PRE)
Recycled plastics - Practical guide for integrating recycled plastics into the electrical and electronic equipment	Eco-systemes (France)
Reuse and recycling of plastic packaging for private consumers	Network for Circular Plastic Packaging (on behalf of the Danish Plastics Federation)
Round Table Eco Design of Plastics Packaging	IK Industrievereinigung Kunststoffverpackungen e.V. (German Association for Plastics Packaging and Films)

It should be noted that **the vast majority of the shortlisted guidelines (24 of the 25) relate to packaging, with only one relating to electrical and electronic equipment**. This is because guidelines in the packaging sector are significantly more developed than those in other sectors. However, the later chapters of this report attempt to draw conclusions and lessons from the analysis of the packaging sector that could also be applied in other sectors.

3.1.3 Additional information gathering on 25 shortlisted guidelines

Following agreement on the shortlist, the study team collected information on the second phase criteria (see Table 3.1), to gather **data on more of the technical aspects of the 25 shortlisted guidelines**. This information was also recorded in Excel spreadsheet format (see Annex 3), and was used as the initial basis for the assessment of guidelines undertaken within Task 3 (see next chapter).

3.1.4 Considerations for next steps

The CPA may wish to consider the following points during their future work on design-for-recycling guidelines:

- Information was received on some interesting additional guidelines after the closure of the final feedback round for this study. In particular, when developing a set of CPA DfR guidelines, it may be worth considering: the **Plastic Sense Foundation's Recyclability guidelines for thermoformed PET trays** (which address both monolayer and multilayer PET trays, consider PET trays as a separate stream of packaging waste from bottles, and consider recycling technologies that are currently available at scale), as well as the **Lidl and Kaufland Style Guides for packaging** (which outline the plastic reduction and recyclability requirements for several categories of packaging).
- This study focussed specifically on design-for-recycling guidelines. However, there is strong value in the CPA also considering **standards, guidelines or tools related to the integration of recycled content** in plastic products, also to help to make the link between design-for-recycling and recycled content.

4 Assessment of existing design-for-recycling guidelines (Task 3)

The objective of Task 3 was to analyse **commonalities and differences** between the shortlisted guidelines (Task 2), consider the **relative effectiveness or "success rate"** of the guidelines in terms of their uptake and ability to positively influence recycling rates; and identify and analyse the **key driving factors behind success**.

The methodology used for the implementation of this Task was based on the following steps:

1. Analysis of commonalities and differences between guidelines
2. Analysis of effectiveness of the guidelines
3. Identification and analysis of driving factors behind their success.

4.1 Analyse the commonalities and differences

The objective of this task was to provide an analysis of the **commonalities and differences between 25 guidelines** shortlisted within Task 2. In the following subsections, the approach is briefly described (4.1.1) and the results summarised (4.1.2).

4.1.1 Methodology

A desktop analysis was undertaken of relevant information collected on shortlisted guidelines during previous study tasks. This was complemented where necessary by additional literature review and further consultation.

Information collected during the mapping of design-for-recycling guidelines in Task 2 (see Annexes) that is relevant to this task includes sector, focus, product type/ group, polymers in scope, definitions / indicators, technical features, minimum requirements/ restrictions/ targets, information and labelling requirements, regulatory obligations and economic incentives, validation requirements, protocols and compliance checks and costs.

Additional data gathering was undertaken to close information gaps with a particular focus on the guidelines' technical features and their minimum requirements/ restrictions/ targets. This was done by carrying out a further review of the guidelines and where necessary direct consultation with issuing bodies.

4.1.2 Results

The results of the assessment of commonalities and differences between shortlisted guidelines is briefly summarised below against key criteria. The assessment included a comparison of both the applicability of the shortlisted guidelines and the approach used. Where applicable, cross reference has been made to the longlist of 108 guidelines and standards.

Design for recyclability protocols provide guidance on design, labelling, marking, after-use infrastructure and secondary markets for plastic polymers and products leading to improved recyclability. They focus on replacing designs that impede sorting and/or reprocessing via the use of known, effective alternatives.

Applicability to product types, product groups and polymers

This section provides a comparison of the shortlisted guidelines according to aspects of their applicability (including sector, focus, product type/group and polymer). Twenty-four of the guidelines are applicable to packaging and one to EEE. Of the 25 shortlisted guidelines, eight were produced by a single issuing body.

Product types, product groups and polymers in scope

The key similarity between the shortlisted instruments is that they ***focus predominantly on the packaging sector***.

68% apply to specific product types (e.g. bottles, trays, etc.) and **36% apply to product groups** (e.g. all packaging, flexible packaging, etc.). Looking at this in more depth, 20% of the guidelines apply to bottles, 16% to trays, 28% to films and 28% to containers. Of the product groups (or packaging types), 28% apply to all packaging types, whilst 12% apply specifically to flexible packaging and 4% to rigid packaging.

Most of the **shortlisted guidelines are specific to either one or several polymers.** Only in one case, no polymer type is specified. 64% of the shortlisted guidelines cover PP, 56% cover PET, whilst 68% apply to HDPE, LDPE or PE in general, to name only the most frequently covered polymers.

Table 4.1 below provides a summary of applicability according to product types, product groups and polymers. The coloured cells indicate the product types, groups and polymers that are covered by each guideline.

Table 4.1. Summary of product types/groups and polymers covered by each guideline

Name of guideline/ standard	Issuing body	Product type						Product group				Polymer								
		Bottles	Trays	Films	Containers	Other	Not specified	All packaging	Light/ flexible	Rigid	Not specified	PP	PS/ EPS	PVC	PET	LDPE	HDPE	PE	Other	Not specified
Borealis 10 codes of conduct for Design for Recyclability for Polyolefin Packaging Design	Borealis						■	■				■						■		
https://circularanalytics.com	Circular Analytics						■	■				■			■	■	■	■	■	
Circular Packaging Design Guideline	FH Campus Wien; Section of Packaging and Resource Management						■	■				■			■	■	■		■	
Citeo 2020 rate list for recycling household packaging	Citeo (France)						■	■				■	■	■	■			■		
cyclos-HTP	Institute cyclos-HTP			■				■				■	■		■	■		■	■	
Design 4recycling. Design plastic packaging so it can be recycled	Der Grüne Punkt	■							■	■		■	■		■	■	■	■	■	
Design for Recycling Guidelines	SUEZ.circpack®						■	■				■	■		■	■	■			
Design Guide for PET Bottle Recyclability	EFBW and UNESDA	■									■				■					
Designing for a Circular Economy Guidelines (draft)	CEFLEX			■					■			■						■		
European PET Bottle Platform initiative (EPBP)	EPRO, EuPR, Petcore, UNESDA, EFBW	■									■				■					
Packaging 4 Recycling	EXPRA's Sustainability and Packaging Working Group						■				■	■	■	■	■	■	■		■	
PETCORE Europe Design for recycling guidelines for PET thermoformed trays: Clear transparent to be recycled even in food applications	PETCORE (PET COntainers REcycling) Europe		■								■				■					
RECOUP	Recycling of Used Plastics Limited (RECOUP)	■	■	■							■	■	■		■		■		■	
Recyclability of plastic packaging: Eco-design for improved recycling	COTREP, France	■	■	■	■	■					■	■			■	■	■			
RecyClass design for recycling (HDPE Coloured Containers)	RecyClass / PRE				■						■						■			
RecyClass design for recycling (HDPE	RecyClass / PRE				■						■						■			

Name of guideline/ standard	Issuing body	Product type						Product group				Polymer								
		Bottles	Trays	Films	Containers	Other	Not specified	All packaging	Light/ flexible	Rigid	Not specified	PP	PS/ EPS	PVC	PET	LDPE	HDPE	PE	Other	Not specified
Natural Containers)																				
RecyClass design for recycling (PE Coloured Flexible film)	RecyClass / PRE																			
RecyClass design for recycling (PE Transparent Flexible film)	RecyClass / PRE																			
RecyClass design for recycling (PO Pots, Tubs, Blisters & Tray)	RecyClass / PRE																			
RecyClass design for recycling (PP Coloured Containers)	RecyClass / PRE																			
RecyClass design for recycling (PP Natural Containers)	RecyClass / PRE																			
RecyClass design for recycling (PP Transparent Natural Flexible film)	RecyClass / PRE																			
Reuse and recycling of plastic packaging for private consumers	Network for Circular Plastic Packaging (on behalf of the Danish Plastics Federation)																			
Round Table Eco Design of Plastics Packaging	IK Industrievereinigung Kunststoffverpackungen e.V.																			
Recycled plastics - Practical guide for integrating recycled plastics into the electrical and electronic equipment	Eco-systemes (France)																			
	Total number	**5**	**4**	**7**	**6**	**3**	**8**	**7**	**3**	**1**	**16**	**17**	**7**	**2**	**14**	**8**	**10**	**10**	**7**	**1**

Key focus or objective

The **guidelines studied apply across the plastics value chain** with a number focusing across different stages e.g. collection (1); sorting (8); or general recycling (2). A number of guidelines focus on closed-loop recycling (12) or on specific end-use applications (5).

There is some variation in the approach used, with many (66%) of the **guidelines providing a matrix** (see Figure 4.1) or **checklist** with which to consider specific product features and/or polymer types which increase recyclability.

Figure 4.1. Examples[11][12][13] of a matrix approach

EMPFEHLUNGEN FÜR RECYCLINGGERECHTE VERPACKUNGEN AUS PET

Recyclingfähigkeit			
Komponente	gut	weniger gut	schlecht
Material und Zusätze	PET	Mehrschicht aus derselben Materialtype	Materialien mit einer Dichte > 1 g/cm³ (z.B. PVC, PS); PETG, C-PET, PLA, PC; dichteverändernde Stoffe; Nanopartikel, Sauerstoff-/ bio-/ oxo-abbaubare Additive
Barriere	keine Barriereschicht, SiOx, Al_2O_3 Barriere	UV-Stabilisatoren, AA-Blocker, optische Aufheller, Sauerstoff-Absorber, max. 5 Gew. % PA, Aluminiumbedampfung (Metallisierung)[1]	EVOH Verbund, über 5 Gew. % PA
Farbe	transparent	blass, helle Farben (z.B. blau oder grün), dunkle Farben[2]	schwarze (carbon black basiert), metallische oder fluoreszierende Farben

[11] Circular Analytics (2019) Circular Design Guideline.
[12] Network for Circular Plastic Packaging (2019) Design Guide Reuse and recycling of plastic packaging for private consumers [PP cup].
[13] RecyClass (2019) Guidelines for PE Coloured Flexible Films.

		Recyclable	Most likely recyclable	Non-recyclable
Clarity		Transparent and light colour-ants are best, but all dyes can be recycled		Carbon black only if NIR sorting is used
Main component (container, bucket, tray, bottle, film)	**Materials**			Fillers that provide a density over 1 g/cm³
	Barriers	AlOx and SiOx coating. MXD6 with compatibilizer	EVOH of more than 1 % of material thickness	EVOH of more than 5 % of material thickness.
	Additives (scaven-gers, anti-fog, anti-slip and similar)			
Elements	**Closures without print** (top film, lid, sealings)	PE and PP plastic laminates	Parts of the main component that do not adhere to PP, alu-minium, paper or other	Parts of the main component that adhere to PP, aluminium, paper or other
	Closures with print (top film, lid, sealings)	PE and PP plastic laminates	Parts of the main component that do not adhere to t PP, aluminium, paper or other	Parts of the main component that adhere to PP, aluminium, paper or other
	Caps and lids	Monoplastic without mineral fillers PP and PE are recommended		All other materials not separat-ed from the packaging through coarse shredding/grinding
Direct print on main components		Direct print and In-Mold-Label in PP		IML, other than PP, that does not wash off in cold water
Labels (adhesive, primary material and printing inks)		PP and PE self-adhesive labels	Parts of the main component that do not adhere to PP, alu-minium, paper or other than PP	Labels made with PET, paper or cardboard that cannot be washed off in cold water. Labels that block NIR sorting. PVC labels

RecyClass™

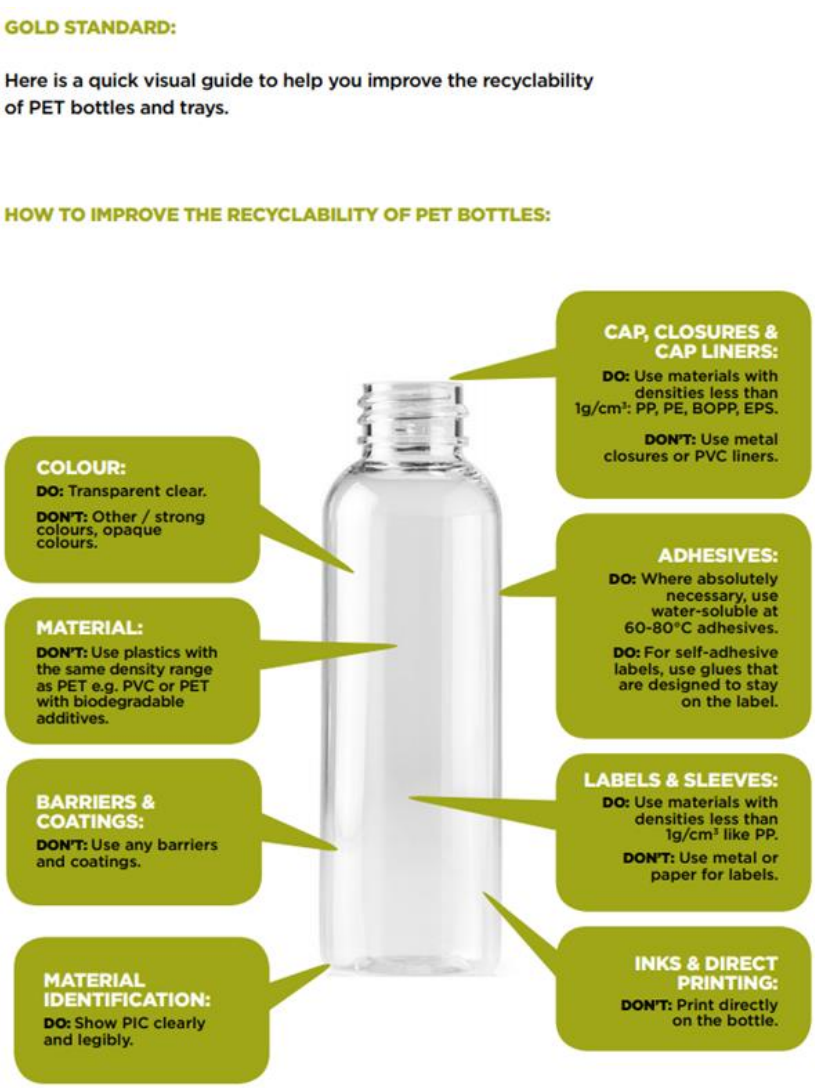
PE Coloured Flexible film

	YES — Full compatibility: Materials that passed the testing protocols with no negative impact OR materials that have not been tested (yet), but are known to be acceptable in PE recycling	CONDITIONAL — Limited compatibility: Materials that passed the testing protocols if certain conditions are met OR materials that have not been tested (yet), but pose a low risk of interfering with PE recycling	NO — Low compatibility: Materials that failed the testing protocols OR materials that have not been tested (yet), but pose a high risk of interfering with PE recycling
Polymer	PE-LD; PE-LLD; PE-HD	multilayer PP/PE	any other polymer
Colours	light colours; translucent colours	dark colours	
Barrier	barrier in the polymer matrix	≤ 5% EVOH (in polyolefinic combination film); metalized layers; "Ecolam High Plus"; "VO+ LLDPE"	≥ 5% EVOH (in polyolefinic combination film); barrier layer PVC; PA, PVDC; any other barrier layer foaming agents used as expandant chemical agents; aluminium
Additives			additives concentration ≥ 0.97 g/cm³
Labels	PE label	PP label; paper label	metalized labels; any other
Adhesives	water soluble (less than 60°C)		
Inks	no inks	non toxic (follow EUPIA Guidelines)	inks that bleed; toxic or hazardous inks
Direct Printing	laser marked; small production or expiry date	printing covering < 50%	printing covering ≥ 50%

Last updated November 2019

The style used within guidelines to communicate this information varies, with many using a combination of factsheet type approaches containing photographs or line art and some providing case studies or good practice examples (see Figure 4.2).

Figure 4.2. Examples[14][15][16] of the styles used



[14] Petco (2019) Designing for the environment.
[15] Cotrep (2019) Recyclability of plastic packaging.
[16] Der Gruene Punkt (2019) Design4Recycling Guidelines.

PP GUIDELINES

Cotrep

BODY

	COLORANTS	BARRIERS	ADDITIVES (BLOWING AGENTS, OPACIFIERS, ADDITIVE LOADS, ETC.)
✓	• All colours (excluding carbon black)	• Coating (SiO_x, CO_x, AlO_x) • EVOH multi-layer • Oxygen scavengers • Carbon black as an internal layer	• Gas, blowing agents and loads that result in d < 1 when combined with PP *
✗	• Dark colorants with carbon black*	• Aluminium barriers • Multiple layers of other resins	• Additive loads and other agents that result in density > 1 when combined with PP

IF YOUR PACKAGING INCLUDES AN EVOH-TYPE BARRIER...

... it can still be recycled in the PP stream given the volumes currently marketed. However, if volumes of packaging containing EVOH were to increase significantly (EVOH levels > 5% of the PP stream), it would no longer be possible to include these types of packaging in the relevant stream.

See COTREP AG 53 for further details

CLOSURESYSTEM

	CAPS	SEALS	OTHER COMPONENTS (VALVES, PUMPS, ETC.)
✓	• PE, PP-based (single or multiple materials of d < 1)	• PE, PP, OPP-based (single or multiple materials of d > 1) • Plastic/aluminium blends that are fully detached for use	• PE, PP, PS of d > 1 • Other materials (silicone, EVA, etc.) of d > 1 *
✗	• Metal	• Metal	• Metal • Glass, paper and cardboard items • PS of d < 1

IF YOUR BOTTLE DISPENSES ITS CONTENTS USING A PUMP...

... solutions are now available that use airless pouches rather than internal metal springs. These 100% plastic solutions are fully compatible with PP recycling since the associated materials are generally LDPE, PP, EVOH, POM or EVA and are used in very small quantities.

See COTREP notices ELIPSO-09-03 and ELIPSO-12-05 for further information

FORTHCOMING STUDIES...

Behaviour of dark PP trays that are identifiable using near infrared technology

DESIGN

	LABELS	INK	GLUE
✓	• PE, PP, OPP*, PET and PS (d > 1) N.B. If material other than PE, PP, OPP, coverage (% surf.): - Volumes > 500 mL: % surf. < 50% - Volumes < 500 mL: % surf. < 70%	• Non-washable (whether applied to the body, label or IML) • Non-toxic (aqueous, plant-based, etc.)	• Washable and residue-free* • Non-toxic (aqueous, plant-based, etc.)
✗	• PVC • PS (d < 1) • PETG	• Highly coloured with a high level of bleed • Metallic inks and other residual inks • Ink bonding agents and overlacquers	• Non-washable in alkaline solution at 60-80°C • Acrylic • Ultra-adhesive or self-adhesive

*A 'They've done it!' feature is provided for recommendations with a * symbol*

✓ *No special restrictions*

✗ *Restricted recycling – check with COTREP*

Cotrep

DECEMBER 2016

THEY'VE DONE IT! →

Best practice examples

What does plastic packaging that is easy to recycle look like? Not much different than other packaging. Because recyclability, attractiveness, and effective advertising all work well together. This is demonstrated by the images of consumer goods on this page.

A lot of packaging is already easy to recycle. Or just a small detail can be changed by using "Design4Recycling", such as the adhesive or the label material, for example. This will not affect the function.

Our examples come from every area of the consumer goods industry – from confectionery products and frozen foods to laundry soap and cleaning agents. All of the packaging shown can be clearly and automatically sorted with machines currently in use. Components such as labels or caps can either be separated easily or even recycled along with the items. High-quality recycled granulates are made from the plastic for use in new products such as mopping buckets, shopping baskets, or automobile parts.

More best practice examples from various areas can always be found at ***www.gruener-punkt.de/en***.

	Pöppelmann Rundtopf PCR blue	Emsal Parkett Pflege	Bofrost Röschen-Trio	Guhl Repair & Balance	Brocker Möhren
Packaging	Plant pot	Bottle for detergents	Deep-freeze film	Bottles for hair care products	Tray and film for vegetables
Material	PP round pot	HDPE bottle, PP cap, paper labels	PP film	PP bottle with PP cap and PP labels or PET bottle with PP cap and PE labels	PP film and PP tray
Categorization for sorting	Clear	Clear	Clear	Clear	Clear
Recyclability	Very good due to mono-material	Very good because labels are easy to separate	Very good due to mono-material	Very good due to mono-material, labels are easy to separate	Very good due to mono-material

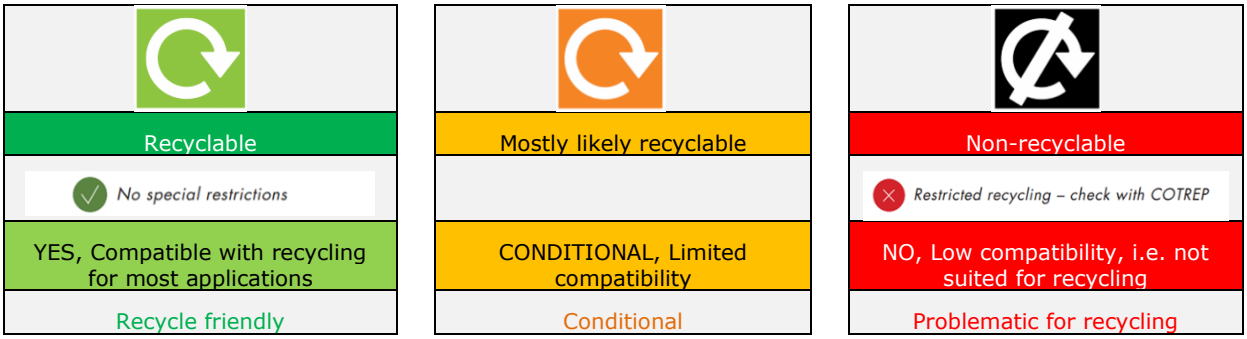
Approach taken

This section provides a comparison of the shortlisted guidelines according to aspects of their approach (including indicators and classification systems, technical features, labelling, validation and costs).

Definitions and indicators

Most (23) of the guidelines utilise specific indicators or categorisations along a spectrum to classify the "degree of recyclability" or "compatibility with recycling infrastructure". The majority provide classifications related to products or product types and use a **three-choice system** to classify items e.g. as "Fully", "Partially" or "Not" recyclable / compatible. As shown in Figure 4.3 below, many of the guidelines also include the use of colour coding.

Figure 4.3. Use of indicators, colour coding and choices to categorise recyclability in guidelines



Technical features covered

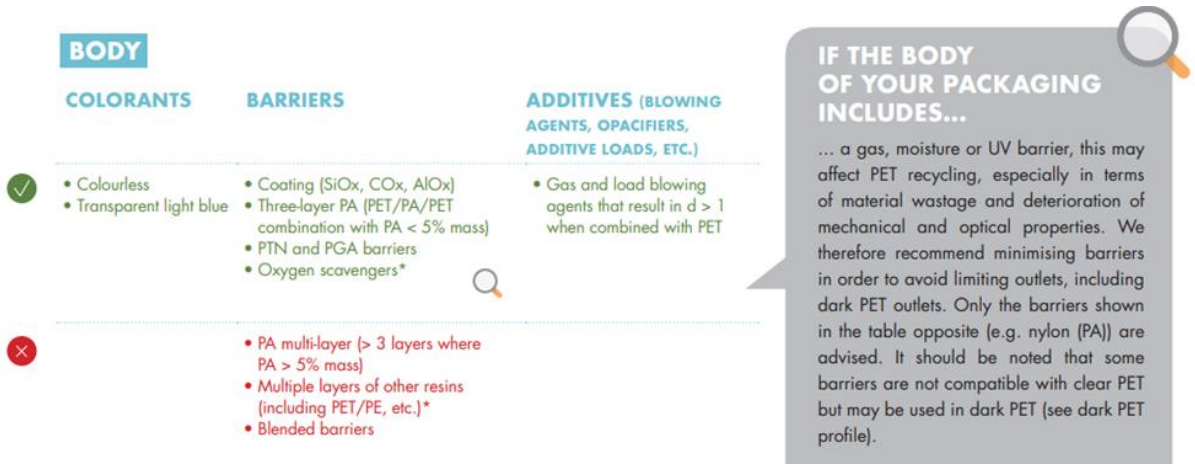
The shortlisted guidelines provide a framework for the use of a wide variety of technical features, including: the choice of polymer or resin; presence of caps; use of seals or sleeves; adhesives; additive printings; inks/dyes; colorants/colours; labels; and barriers/coatings.

Over **75% of the shortlisted guidelines define design characteristics related to common features such as colours and labels**. More than half also consider resin or polymer type, additives and printing. Different guidelines covering common polymer and product type combinations have similar recommendations although they provide them in different forms and levels of detail. Some examples of the recommendations for the use of colourants, barriers and additives in PET bottles are provided in the Figures below.

Figure 4.4. Design Guide for PET bottle recyclability([17])

PET BOTTLE	RECYCLE FRIENDLY	CONDITIONAL	PROBLEMATIC FOR RECYCLING
Colourants, fillers and additives	Clear / natural Light (blue or green) tints	Dark blue / black if NIR detectable Dark green and brown Optical brighteners O_2 scavengers; UV stabilisers; AA blockers	Non-detectable Dark, opaque, metallic, solid colourants Any use of fillers. Nanocomposite barrier fillers Bio/Oxo/Photo Degradable Additives
Barrier coatings Blended barrier resins & barrier layers	Clear plasma coatings e.g. CVD SiO_x, Monox Other layered barrier materials that separate and do not cause yellowing	PEN / Amosorb / MXD6 barrier multilayer (if <3% total bottle weight)	EVOH >3% in multilayer Amosorb, MXD6 > 5% in multilayer Any direct blended barrier based on ie EVOH, MXD6

Figure 4.5. Recyclability of Plastic Packaging([18]) (recyclability profile - clear PET: guidelines)



Minimum requirements, restrictions & targets

More than half (13) of the shortlisted guidelines include some form of restriction regarding **material composition** and or **specification** of particular features. Of these, 10 set minimum requirements to achieve full compatibility. These include consideration of use of **particular features**, e.g. additives or inks, and in some cases set **minimum values** for incorporation of particular elements e.g. water solubility (at a set temperature) of adhesive, density of label and/or product, % material composition.

Some guidelines (7) identify and set targets; the remainder do not. Of the targets indicated, one is **numerical**: aiming to double the plastic packaging recycling rate nationally. The remaining targets seek to **increase recycled content** and/or **improve recyclability**.

Information and labelling requirements

14 of the guidelines provide or rely on the achievement of some form of logo or label. 7 do not (for 4, no information on labelling was available).

[17] EFBW (European Federation of Bottled Waters) and UNESDA (Union of European Beverages Associations) (2011) Design Guide for PET bottle recyclability.
[18] European Strategy for Plastics (European Commission 2018)

Figure 4.6. Examples of logos and labels used by shortlisted guidelines

Regulatory obligations and economic incentives

A significant number of the **guidelines align either to regional or national legislation** or targets. Of the guidelines aligning to legislation, eight relate to EU legislation([19]), two to national legislation([20]) and two to both. One guideline aligns to the global **sustainable development goals** (SDGs). None of the shortlisted guidelines refer to economic incentives.

4.2 Analysis of effectiveness of guidelines

This task aimed to analyse the **effectiveness or "success rate"** (e.g. uptake/ market penetration/recycling rates) of the shortlisted guidelines. In the following subsections, the approach is briefly described (4.2.1) and results and key findings are summarised (4.2.2).

4.2.1 Methodology

The task is based on the desktop analysis of relevant information collected during previous tasks, which is complemented where possible by additional literature review and additional consultation.

Information collected during the mapping of design-for-recycling guidelines in Task 2 (see Annexes) that is particularly relevant includes perceived effectiveness, market penetration/ uptake, material flows([21]), recycling rates achieved/ achievable, best practice/success factors, and minimum requirements/ restrictions/ targets (as a measure against which effectiveness can be assessed). Relevant information from the mapping of material flows from Task 1 was also used: the average current recyclability and current content of recyclate in products was calculated for the materials and products relevant for each shortlisted guideline.

Additional data gathering was undertaken to close information gaps with a focus on the guidelines' ability to drive uptake by relevant value chains and increase market penetration, positively influence recycling rates and underlying driving factors for this. A targeted, brief email survey of the issuing bodies of the shortlisted guidelines was conducted. A set of questions around the broad themes of effectiveness, efficiency, good practices and drivers, and coherence was developed. The full set of questions and a list of organisations approached is provided in Annex 4. By the time this report was finalised, 13 issuing bodies had responded with additional information regarding 20 of the shortlisted guidelines. In addition, telephone interviews were conducted with the Design Coordinators of the five CPA sectoral working groups, focusing on the relative importance of different barriers and challenges, as well as best practices and drivers for the implementation and success of design-for-recycling guidelines.

[19] EU legislation alignment to: Directive 94/62/CE (last amended by Directive 2018/852); EU Directive 2019/904 (Single Use Plastics); EU Directive 1999/31 (Landfill); EU Directive 2008/98 (Waste Framework); European Strategy for Plastics in a Circular Economy; EU Circular Economy Action Plan

[20] National legislation alignment to: UK Packaging Waste Regulations and German Packaging Act (VerpackG)

[21] E.g. volume of products/ polymers designed based on the guideline/ standard, volume collected/ sorted, outputs of recycling plants, end use applications, loss rate from collection/ sorting/ reprocessing.

4.2.2 Results

The results of the assessment of effectiveness of shortlisted guidelines is briefly summarised below against key criteria.

Perceived effectiveness

Of the 25 guidelines, 5 were initially ranked by the study team in task 2 as "high" **perceived effectiveness** and 13 as "mid", based on limited information found and expert judgement. For the remaining guidelines no information was available to make a judgement.

Additional consultation with several of the guidelines' issuing bodies provided the following examples of indications of effectiveness:

- COTREP guideline "Recyclability of plastic packaging: Eco-design for improved recycling": results of an initial trial in 2016 suggested an 11% increase in lightweight materials recycled. COTREP also influenced PET bottle design with PP labels (instead of paper labels) on 98% of recyclable bottles on the French market, however it is difficult to judge the contribution to the recycling rate which also depends *inter alia* on collection. COTREP helped to move from 50% of pots, trays, tubes and flexible packaging being readily recyclable in 2012 to approximately 75% by the end of 2020[22].
- Two issuing bodies provided an indication of recycling rates of specific products in the EU (the PET packaging recycling rate across Europe is around 50% with PET being the most recycled packaging polymer) or in specific countries (clear PET mono material trays are now collected and recycled "at scale" in France, with efforts ongoing for tray recycling implementation in the Netherlands, Belgium, Germany, Italy, Spain and Portugal), although it is not clear what proportion of this can be attributed directly to the guidelines.

Market penetration/ uptake

Of the 25 shortlisted guidelines, 16 were initially ranked by the study team in task 2 as "high" perceived **market penetration/uptake** and 7 as "mid". For the remaining guidelines, no information was available to make a judgement.

Several guidelines have been set up by industry associations, some of which have the **core aims of improving recyclability and recycling**. Presumably these guidelines could be taken up by all relevant members of the associations, although typically information was not available on whether this is the case in practice (and often many members are themselves recyclers, rather than producers of plastic articles that could implement design-for-recycling).

Some guidelines are issued by recyclers, who report partnerships with producing companies, although **market share or uptake are typically not quantified**.

Following additional consultation with several of the guidelines' issuing bodies, there was still no information available in a suitable common metric to compare the relative uptake or market penetration of different guidelines. However, the following examples of quantified indications were identified:

- EXPRA stated that their members' compliance schemes in 17 EU Member States are currently working towards the Packaging 4 Recycling guideline's objectives. The tool aims to facilitate users' access to best practices and guidelines, across Europe, on packaging design, labelling, collection systems and sorting, thereby helping products to be designed to enable collection, sorting and recycling.
- RecyClass stated that their online platform/tool is used by over 2,500 product designers around the world (mainly in Europe and the US), with around 550 product analyses currently performed each month. Signatories of the Ellen MacArthur Foundation's Global Commitment are using the tool to assess the recyclability of their products and it is reported that some retailers are beginning to ask suppliers to benchmark their products (including HDPE, PP and PO containers, PP flexible films and PE films) against the RecyClass methodology.

[22] Note the original response stated "75% by the end of the year", which was assumed to mean 2020.

— The European PET Bottle Platform initiative (EPBP) stated that more than 30 applications have been considered, with 13 approved so far by the technical expert panel. EPBP reports that major brand owners repeatedly state that they require suppliers to comply with the EPBP guidelines, and that the vast majority of PET bottles on the European market now meet the EPBP guidelines.

— According to the Danish Plastics Federation, in April 2020 all Danish supermarkets prepared a general design manual for packaging, which recommends use of the "Reuse and recycling of plastic packaging for private consumers" design guide for packaging made of plastics.

— Circular Analytics' Circular Packaging Design Guideline is reported to be used by more than 25 companies from the packaging industry.

— CEFLEX currently has 160 stakeholders across the full flexible packaging value chain (with over 6,000 European sites). Since the launch (June 2020) CEFLEX is monitoring the number of companies/organisations accessing the D4ACE guidelines (Designing for a Circular Economy Guidelines – CEFLEX) and will gather data on number of participants, adoption, volume of products, etc. At the time of writing, there were 360 registrations within one week of the launch.

— COTREP stated their guideline covers the whole French market of rigid PET, PE, and PP household plastic packaging (1.2 million tonnes).

— Cyclos-HTP and Der Grüne Punkt have made approximately 2,500 analyses and certifications since 2014, covering mainly packaging with high sales volumes from multinational companies. The Cyclos institute catalogue has been accepted as the basis for the minimum standard to assess recyclability of the German Central Register (ZSVR) which was first published in 2019 in the context of the new Packaging Act (VerpackG).

Material flows and recycling rates achieved/ achievable

It should be noted that **recycling rates are influenced by a wide range of factors** (discussed in further sections) **and therefore not a stand-alone indicator of the effectiveness of the guidelines.** Furthermore some guidelines: **overlap in the products they cover** (hence making it difficult to distinguish which guideline contributes to an achieved recycling rate); **have only recently been introduced** (hence have not yet had an impact on recycling rates); or are **used only in specific countries** (hence their impact is only reflected marginally in the total EU recycling rates). Sufficient data was not available to compare recycling rates before and after the introduction of design-for-recycling guidelines, although this may become available and could be collected in the future, particularly once guidelines are more mature and have had a clear impact on the market.

Specific information collected includes:

— Recycling rates in France (where the respective guideline, CITEO's eco-modulation of rates for household packaging, is applied) in 2018: total plastic 26.5%, beverage/other bottles 58%, other plastic packaging 4%.

— For several guidelines, examples of specific products that comply with the guideline (and in some cases their recyclability in percent) are available. For example, Der Grüne Punkt's website includes 20 best practice examples of packaging that meet its "Design 4 recycling" guideline.

— PETCORE Europe "Design for recycling guidelines for PET thermoformed trays": Almost 50% of material in PET trays is rPET. However, the main source so far has been clear bottle flakes and with pressure for PET bottles to incorporate 30% or more recycled content, available feedstock for trays is diminishing.

Regarding **potentially achievable recycling rates**, some of the guidelines refer to specific quantified targets (although no data is available on their success in contributing to those targets):

— Danish Plastics Federation: working towards a recycling rate of 60% (by 2025) for both rPET of food grade quality and PP and PE for non-food packaging (the recycling rate for all plastic packaging in Denmark currently stands at 18%).

— COTREP guideline "Recyclability of plastic packaging: Eco-design for improved recycling": Extending bottle sorting instructions to all plastic packaging is expected to recycle 20,000 extra tonnes per year of plastic

packaging. The targets are to increase recycling rates as follows (from 2016-2030): bottles 55% to 82%; pots, trays and other rigid packaging 1% to 55%, film 1% to 23%.

— CEFLEX "Designing for a Circular Economy Guidelines" (D4ACE): aim for over 80% of collected flexible plastic packaging to be returned to the economy and used to replace virgin materials. The Phase 1 D4ACE guidelines focus on polyolefin-based structures – representing 70-80% of total volume placed on the market. According to CEFLEX, whilst it is too early to assess the uptake of the forthcoming D4ACE guidelines, most of its member brand owners and retailers have already started reviewing their packaging portfolios and are starting to substitute multi-material flexible packaging with mono-material equivalents where possible as recommended in the D4ACE guidelines.

— PETCORE Europe: has pledged to achieve an average use of 70% recycled PET for sheets and trays, representing use of around 2.07m tonnes recycled PET per year, by 2025 (compared to 1.23m tonnes in 2017).

Costs of implementation

Available information on the **different types of costs** of implementing design-for-recycling guidelines is summarised below:

Membership fees

— Nine issuing bodies specified that their guidelines **do not require a membership fee** from their users. Three indicated that the costs are effectively paid for by the members of the issuing bodies ([23]).

— Two further guidelines state on their websites that they are generally **free of charge**, although for one of them country-specific information must be paid for. The other is an informative guide for self-assessment.

— RecyClass (responsible for eight of the shortlisted guidelines) offers three levels of membership, based on the level of support (costing €3,000, €5,000 and €10,000 per year, respectively), which are used for undertaking internal tests by the technical committees responsible for the development of the guidelines.

— Der Grüne Punkt **charges** a one-time €300 fee for accessing the RecyclingCOMPASS online tool for an initial assessment of packaging recyclability (although it is free for Grüne Punkt clients[24]).

Certification fees

— RecyClass specified that **certification** incurs a €600-800 **charge** by an external auditor.

— Der Grüne Punkt indicated certification fees of €600-1,500 per packaging type, depending on its complexity.

— Two issuing bodies (PETCORE and EPBP) clarified that there are **no certification fees** in their guidelines, however participants pay for their own testing costs that can lead to certification.

— For all other guidelines, **information on certification fees was not available or not relevant** because no certification is provided.

Testing costs

— Under two guidelines, **companies pay for their own testing**. PETCORE specified this involves evaluation by external laboratory tests for a specific application, estimated at between €20,000-50,000 per test. EPBP stated that tests are based on a testing plan defined by the technical experts and the companies own the results, but the cost was not estimated.

— RecyClass estimated testing costs of roughly €10,000 depending on the tests performed, charged by independent laboratories.

[23] Members pay contributions to these issuing bodies, some of which are charities, in order to support the causes pursued by the issuing body (including but not exclusively, increasing recycling). This could be as part of their corporate sustainability efforts or because they benefit from increased recycling (e.g. waste operators or local governments).

[24] Der Grüne Punkt offers a range of services, so the costs of being considered a client could vary widely, but in most cases is likely much higher than the €300 fee for accessing the RecyclingCOMPASS as a non-client.

— Der Grüne Punkt estimated testing costs of approximately €500, mainly for paper/composite packaging.

— Recoup provides testing at sorting facilities **free for members** (although non-members can use the guideline for free and it was not clear if testing costs apply to them).

— COTREP stated the tests they conduct do have a cost, but it is **supported by their members** with a budget (in total approximately €150,000 per year).

— For all other guidelines, **information on testing costs was not available or not relevant** because no testing is undertaken or required.

Compliance costs

— Der Grüne Punkt noted the main costs facing producers are the ones involved in **changing packaging designs** and that these can reach into the millions of Euros.

— Quantitative **estimates of costs** (e.g. Euro/tonne) to comply with technical requirements were **not available for any other guidelines**.

— Another issuing body stated they expect the compliance costs of recyclable packaging to decrease due to upcoming fee modulation within EPR.

Any other costs

— One guideline (Citeo) is a list of euro EPR rates (non-binding, for informational purposes) for packaging products that reflect their recyclability (more recyclable products incur lower rates).

— Two issuing bodies (Network for Circular Plastic Packaging and Circular Analytics) responded that the most important costs are **innovation and development costs** for developing circular packaging designs or solutions.

Benefits

— The issuing body of one guideline focusing on integrating recycled plastics into electrical and electronic equipment stated that there could be a **net benefit** (i.e. negative compliance cost) because recycled plastic can be less expensive than virgin plastic([25]). However, it should be noted that the issue of prices is complex; they fluctuate and vary by polymer, so this cannot be assumed to be true in general.

In conclusion, **costs can vary substantially across the different guidelines and there are different systems regarding how costs are borne**. While some guidelines charge a membership fee for users (ranging from hundreds to EUR 10,000), others are free to use and effectively paid for by the members of the issuing bodies. In general, **testing costs appear to be the most significant cost factor for users** (for those guidelines where testing is applied), while **certification costs are generally more modest**. The costs of changing products to achieve compliance with guidelines could not be quantified, but could potentially be substantial (up to millions of euros according to one estimate). Comprehensive data to assess total costs for guidelines and percentage cost breakdown for the different actors involved was not available. However, **in general, costs are borne mostly by users of the guidelines** (i.e. producers of items) **and to some extent by members of the issuing bodies**. Not much information was found regarding potential benefits of the guidelines, but in principle benefits could accrue both to society as a whole (from increased recycling), and also, for instance, to recyclers (more high quality feedstock) or producers of items (e.g. through reputational benefits or EPR savings).

[25] The guideline states that in 2016, the difference between recycled material and its virgin version was around €300/t for PP and could reach up to €800/t for ABS (See: ESR (2019) Recycled plastics Practical guide for integrating recycled plastics into the electrical and electronic equipment). However, it should be noted that prices fluctuate and vary by polymer, so this cannot be assumed to be true in general.

4.3 Analysis of driving factors behind success

4.3.1 Methodology

This task combines the results of previous parts of Task 3 (the key criteria of guidelines, how they differ or have commonalities, and the effectiveness or success of the guidelines) to determine which criteria of the guidelines and which external factors appear to be key drivers of success. It also uses information gathered in Task 2 on the barriers and challenges to implementation of guidelines and of recycling (which can be internal or external factors affecting their effectiveness) as well as the study team's ideas on potential best practices and success factors. This information is complemented by several steps of consultation:

- The targeted, brief email survey on effectiveness, efficiency, good practices and drivers, and coherence of guidelines, as discussed in the previous subtask;
- A dedicated session held during a webinar with CPA signatories on 27 May;
- Further targeted stakeholder interviews focussed on validating the potential driving factors identified and assessing their relative effectiveness.

The relevant information identified from previous tasks, the email survey and the targeted stakeholder interviews is summarised in the following subsection.

4.3.2 Results

Barriers/challenges to implementation

The following barriers and challenges relating to the **implementation of guidelines** themselves have been identified (categorised by approximate relative importance, based on input from consulted stakeholders and interviews with CPA Design Coordinators):

- Most significant:
    - A **lack of transparency, precision and consistency** regarding the criteria applied in assessments of recyclability, notably in the context of EPR modulation fees. In particular, transparency was highlighted as a significant issue by two CPA Design Coordinators.
    - If guidelines focus on specific countries, their **implementation beyond their focus countries will be limited** and they will be subject to respective national limitations (e.g. certain polymer streams are recycled in some countries but not yet in others). Some stakeholders see a country focus as a key barrier, because an EU-wide harmonised approach provides transparency and economies of scale (cf. product design for the whole EU market). However, collection, sorting and recycling are not harmonised across Member States, which could at least in the short term be a barrier to harmonised guidelines. CPA Design Coordinators also acknowledged that **country specificities need to be respected**, but an EU-harmonised approach was still seen as key by most consultees.
    - Several stakeholders and CPA Design Coordinators highlighted that in some cases, it is a challenge to combine (full) recyclability with (full) **functionality of a product**, for example different requirements of filling goods for product protection or brand manufacturers' marketing requirements.
    - There is a **lack of guidelines for the use of recycled polymers within certain applications** (e.g. cosmetics and detergents). This point was supported by two CPA Design Coordinators who identified new products in the construction sector and the automotive sector in general as examples.
- Medium significance:
    - Some guidelines do not provide technical specifications, but rather **broad design principles** or checklists, which was considered a significant barrier by a CPA Design Coordinator, particularly in the packaging sector.

- One CPA Design Coordinator also highlighted a current **lack of test protocols** as an important issue.

— Lower significance:

- **Lab testing and audit costs** could be a **barrier** to achieve higher uptake of guidelines and also to the certification of products, although this was not highlighted by any consulted stakeholder([26]). CPA Design Coordinators had mixed opinions on the issue, with one agreeing this is a barrier, while two did not consider it a significant barrier.
- **Costs for re-designing packaging**, as well as the lack of incentives to use recycled materials from household collection.
- **Uncertainty regarding future developments** and how these will impact on product design in the near future was mentioned by stakeholders, although two CPA Design Coordinators noted this was not a significant issue and could be overcome, since this is the case for all products.

Additional barriers and challenges relating to the **implementation of recycling** more generally have also been identified in literature review during previous tasks, in the email survey and in the targeted stakeholder interviews. These constitute external factors that may affect the success of design-for-recycling guidelines and are summarised below:

— For recycling of plastics from WEEE:

- **High diversity of polymers** used and the lack of critical mass for sorting in recycling facilities;
- **High technical and regulatory requirements** (e.g. legacy substances) of materials used;
- **Specific substances of concern**: brominated flame retardants, cadmium containing colouring compounds;
- **Loss/unavailability of feedstock** due to export of WEEE, small electronic equipment often ending up in domestic waste, and the long lifetime of products.

— The **performance of** the **current collection systems**, in general, is **not always adequate** to ensure a high quality and quantity of recycled material. The diversity of these systems at the national and local levels imposes uncertainty and may hamper investments by industry.

— The **cost** of improving recycling capacities and upgrading infrastructure has also been recognised as a barrier.

Ellen MacArthur Foundation (2017) identified as **barriers to increased recycling of plastic packaging**: the **small format of some packaging** (10% of plastic packaging by weight), **multi-material packaging** (13% of plastic packaging by weight), **uncommon materials** (10% of plastic packaging by weight) and **nutrient contamination** (not quantified).

More specific issues related to the **specific attributes of packaging** currently are:

— Full sleeves, or sleeves that cover more than 60% of a container can lead to an **error in the identification of the material used** for the container itself and can also cause quality issues;

— **Top film** which is **not compatible with the main container** e.g. a tray, and is difficult to remove, can cause defects and issues with the quality of the resulting recycled material;

— Technical challenges associated with **opaque/coloured PET**;

[26] Note however that the consultation focused on issuing bodies, so further consultation with users would be required to confirm whether they consider this to be an issue.

- For HDPE and PP containers, and for PO pots, tubs, blisters and trays, the main challenges for recyclability (both in quantity and quality) relate to **decorations and closure systems**. For the PO items, **sorting behaviours** are also a key challenge;
- For PE and PP films, key barriers to achieving higher quantity and quality of recycled material are the **use of multilayer / multi-materials** (PP coupled with PET, PA, PVC, PVDC; polymers coupled with metals), **decorations** (e.g. heavily printed films), and **multilayer PP+PE items**;
- When rPET derives from non-food contact applications, it is **not possible to use it in food contact applications** (in conformity with applicable EU legislation). End-users in general prefer rPET from food contact applications to ensure certain quality standards are met, even for non-food applications (e.g. cosmetics);
- The evolution of packaging, particularly in relation to the selection of polymers in products (e.g. the substitution of PVC with PET on trays, while PET recycling facilities were designed to process bottles);
- More generally, the **increased complexity of packaging** creates a number of challenges to recycling. **Further guidance is needed** on more complex, multi-material structures and elements of flexible packaging structures.

Several issues related to **recycling infrastructure** have been identified. One issuing body highlighted a **lack of infrastructure to adequately collect and sort plastic**, particularly at a local level. **Making collection/sorting** (particularly of flexible packaging) **economically viable** and **ensuring adequate infrastructures/material separation** is a challenge. Significant investments are required to implement advanced sorting technologies (the average price of a sorting machine is around EUR 300,000).

The quantity, composition and quality (level of contamination) of feedstock supply fluctuates. For instance, one guideline issuing body highlighted the **difficulty in sourcing raw materials of sufficient quality and quantity** to achieve food grade recycled PET.

Strict requirements regarding the quality of the recycled material (e.g. safe to use as a food contact material, aesthetic aspects, odour, etc.) may hamper the uptake of recyclate.

Best practice/success factors

With regards to potential **best practices** contributing to the success of design-for-recycling guidelines, the following have been identified:

- **General approach to guideline development** (approximately categorised by relative importance, based on input from consulted stakeholders and interviews with CPA Design Coordinators):
    - Most significant:
        - The desirability of **a holistic and EU-harmonised approach** to guideline development was pointed out by several stakeholders and all CPA Design Coordinators (two highlighted it as the most important success factor). This includes taking into account product design, life cycles, the potential to use the resulting recycled material, as well as national regulations and collection, sorting and recycling infrastructures. Contact with regulatory and legal authorities is helpful to understand the legal framework in which the guideline will operate. However, some stakeholders consider that guidelines should only reflect material compatibilities based on material chemistry and not be linked to national settings (such as collection and sorting);
        - **Involvement and commitment of the whole value chain** in the development and promotion of the guidelines was also pointed out by several stakeholders and all CPA Design Coordinators (two highlighted it as the most important success factor). This can be done for example via collaborative platforms (such as the one provided by the Circular Plastics Alliance) and potentially also include environmental and consumer organisations. Some guidelines are developed directly by organisations with practical waste management experience, or draw on the experience of other existing industry-led guidelines. Some stakeholders consider that involving the whole value chain can help

achieve the appropriate balance between functionality and circularity and lead to impartial guidelines;

- Medium significance
  - **Regular updating of guidelines**, to reflect (inter alia) new data on innovations, technologies, results of product testing (e.g. in laboratories and/or recycling facilities) and market developments, as well as feedback from members of the issuing bodies, to further improve the quality of recycled materials and therefore their uptake by end users. This was supported as a significant success factor by all CPA Design Coordinators;
- Lower significance
  - Guidelines should be based on **pilot testing**, not only laboratory scale tests.

— **Specific features/elements of guidelines** (approximately categorised by relative importance, based on input from consulted stakeholders and interviews with CPA Design Coordinators):

- Most significant
  - Provision of **certification or a label**, to be used by products that comply with the requirements of the guideline, was noted by several stakeholders and four of the CPA Design Coordinators;
- Medium significance([27])
  - Ensuring that guidelines are **clear, concise and easy to follow** (in some cases including developing different versions aimed at different audiences). Providing worked examples of products to show how to apply the guideline (e.g. substituting coloured with clear bottles to enhance recyclability);
  - Provision of a **publicly accessible methodology** upon which the guidelines were based, including how recyclability is assessed;
  - Inclusion of **general design criteria** plus **polymer-/product-specific criteria** that require the definition of different thresholds; some stakeholders consider that general design criteria should not overreach across product sectors as it will dilute the utility of a guideline; one CPA Design Coordinator suggested the most important generic criteria is to use a recyclate;
  - Consideration of other **elements of sustainability for packaging**, such as recognising the role of optimised resource use, reuse, use of recycled material, sustainable sourcing of materials etc.;
  - Development of **guidelines for disruptive technologies** where pilots with promising results exist (e.g. delamination, PET monomer recycling);
  - Provision of **simple, and free, self-assessment tools** alongside the guidelines, to allow producers to do an initial quick and simple check of their own products against the guidelines. This may be in the form of online tools or quick laboratory tests;
  - Provision of **assessment protocols** to be used to demonstrate compliance with design criteria (note that this was supported as a success factor by three CPA Design Coordinators but not seen as an important issue by another).

— **External/contextual factors mentioned by consulted stakeholders that can improve the effectiveness of the guidelines**:

[27] The factors listed below where all supported by 2-3 CPA Design Coordinators as significant success factors. No factors with lower significance (i.e. that were not supported by CPA Design Coordinators) have been identified.

- Major players (e.g. retailers) obliging their suppliers to adhere to a specific guideline;
- **Improved collection of waste**, e.g. **collection targets per polymer or product** (e.g. collection targets for PET bottles in the Single-Use Plastics Directive), awareness raising among citizens;
- **Eco-modulation of fees** within EPR schemes according to the recycled content or recyclability of products;
- **Systematic, harmonised information** on the recycled content of products;
- Availability of **suitable infrastructure** to collect, sort and recycle plastics, also for non-household waste;
- Improved sorting of waste, including through the **application of innovative technologies** such as "watermarks" with the involvement of the whole value chain, including EPR schemes and waste management entities;
- **Improvements on the safety assessment** process of recycled materials, particularly in relation to food contact packaging;
- Existence of demand for recycled materials: **sustainable end markets** for recycled polymers are necessary to encourage and justify design-for-recycling;
- Consistent **strategy for plastic recycling** by European and National Authorities

Coherence with other initiatives and regulatory requirements

With regards to the extent to which the guidelines fit within existing regulatory requirements, the following responses have been gathered:

— Eight issuing bodies stated their guidelines are **aligned with current regulatory requirements**. One specified their guideline is based on the Austrian Packaging Ordinance. One completely covers the requirements and definitions of the minimum standard of the German Central Packaging Register (ZSVR). One was created to help companies to comply with the Packaging Directive and essential requirements on recyclability in France. Another collects and makes available information on the existing regulatory requirements. One issuing body responsible for 8 of the shortlisted guidelines specified they are fully aligned with the Circular Plastic Strategy, the Packaging and Packaging Waste Directive (PPWD) and Ecolabel. However, one issuing body noted that in their opinion legislation such as the Single Use Plastics Directive is not helpful, since it does not consider the full environmental impact.

— One issuing body notes **there is no legislation covering recyclability of products** in the country where its guideline is applied.

With regards to the support provided by the guidelines to the implementation of legislative requirements or other initiatives, the following information has been obtained:

— One issuing body is in contact with other organisations to **ensure that conflicts between guidelines are avoided** (although minor differences may arise between countries with different preferences in packaging). Another says it is endorsed by several stakeholders and respective associations.

— One issuing body stated that its **guideline supports the implementation of legislative requirements** by providing the entire industry with an overview of European directives.

— Two guidelines specifically support EPR. One of them specified their guideline supports the eco-modulation of EPR fees, as well as the PPWD Essential Requirements which are under revision.

— One issuing body explained that tight **regulation could increase recyclability in the short term but should be flexible** enough to allow for the necessary innovation in all steps of the value chain to support the long-term transition to the circular economy.

4.3.3 Considerations for next steps

The CPA may wish to consider the following points during their future work:

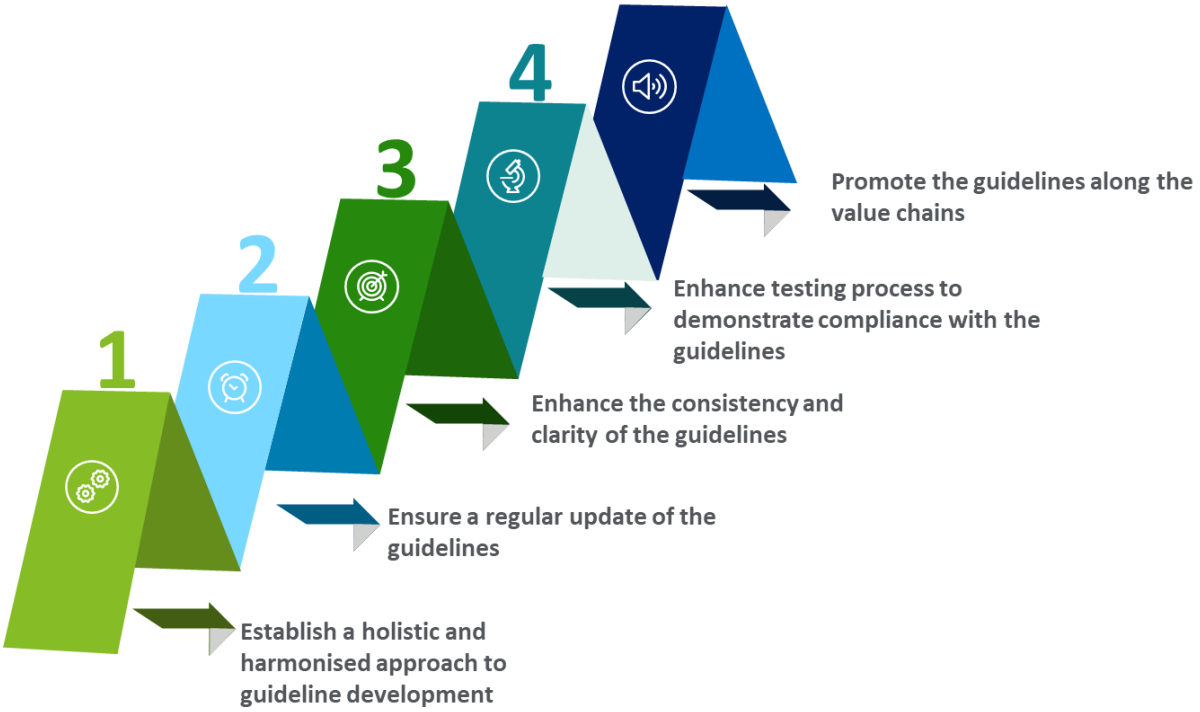
- Limited information was received regarding the **market share/penetration of most guidelines**. This aspect could be further investigated if there is additional information about (1) market share/penetration of DfR guidelines, in order to further refine conclusions on which properties of guidelines are favourable for achieving a high uptake, and (2) what approaches are used by guidelines/standards in other fields, so that they could potentially be used to generate market share/penetration data for DfR guidelines.
- Many issuing bodies of guidelines pointed out that it was too early to judge the effectiveness of guidelines in terms of their impact on recycling rates. Hence, the **effectiveness of guidelines would deserve to be reviewed again in the future**, particularly in order to judge their contribution to the target of securing 10 million tonnes per year of recycled plastic content within the EU market.
- Interviews have been undertaken with the CPA Design Coordinators to further determine the **relative importance of the identified driving factors.** However, further work could be useful to investigate this issue and elaborate on how the most important factors support or impede the effectiveness of DfR guidelines.
- A **wide variety and range of costs for implementing DfR guidelines** has been identified. This is particularly true for testing costs. While it is clear that costs could deter some producers from implementing a guideline and therefore affect their market penetration, it is also clear that some costs are necessary in order to finance and ensure the effectiveness of the guideline (e.g. by testing and certifying recyclability). Further work could investigate the **appropriate balance between costs and effectiveness** of guidelines, as well as how costs are balanced by savings elsewhere (e.g. reduced EPR fees) or income (e.g. from selling high quality recyclate).
- Stakeholders noted that there is a lack of suitable recycling plants in Europe to conduct **pilot testing of the practical recyclability of products**. This availability and the effectiveness of available infrastructure to identify where additional capacity and investment is required could be investigated.

5 Recommendations for a future CPA work plan for design-for-recycling guidelines (Task 4)

The sections below provide a list of the study team's recommendations for the CPA to consider when drafting its work plan for design-for-recycling guidelines. These ideas correspond to a set of recommendations concerning the **removal of barriers**, and **creation or reinforcement of drivers**, to achieve **increased effectiveness of guidelines**.

To feed in to the CPA's draft Design-for-Recycling Workplan the recommendations aim to support the enhanced recyclability of plastic products or product parts, thereby also contributing to generating a sufficient quantity and quality of plastic waste (feedstock for the target of 10 million tonnes recycled plastics to be used annually in the EU by 2025).

Figure5.1. Outline of recommendations



Based on the work undertaken during the study, including a review of responses to the stakeholder consultation, inputs from the shortlisted guidelines' issuing bodies and additional targeted interviews, the study team propose the following recommendations for consideration by the CPA during the development of its design-for-recycling guidelines.

1. Establish a holistic and harmonised approach to guideline development	
Description	• Ensure a holistic and EU-harmonised approach in the development of guidelines, to address in a comprehensive and a transparent manner the **needs and limitations** that exist across the whole value chain and across the EU market • Enhance the applicability of guidelines in all EU Member States by considering **national specificities** (e.g. legislative requirements, existence of infrastructure per polymer stream, structure and effectiveness of EPR, waste collection and sorting schemes)
Actors involved	The establishment of a harmonised approach needs to be led by the **guideline issuing bodies** but would also require the **participation of the whole value chain**, particularly EPR schemes, recyclers and end users who have a solid knowledge and understanding of the technical limitations and requirements for the end products
Timeframe	3 years

The plastics value chain is characterised by certain needs and limitations. The composition of plastics, and more precisely the organisation of the polymers and the nature and proportion of these substances, changes according **to specific technical and marketing requirements**. In general this increases the complexity of products and consequently causes difficulties in the end-of-life treatment. These difficulties are becoming more complex in certain products with long lifespans. Typical product lifetimes range from 5-20 years for EEE, 15-20 years for vehicles and 5-100 years for buildings. This limits the effect of the existing guidelines on the recyclability of such products into the future. Whilst there is currently a long list of guidelines for hundreds of products, for many the available data on their recyclability is limited, also due a lack of transparency.

While the establishment of an overall transparent and holistic approach is difficult, this could be addressed through the development of **guidelines addressing specific groups of products, polymers and/or sectors.** This can be achieved through a vertical integration, starting from guidelines that are effective for certain products and then adapting them to address whole product families. For example, the approach taken in developing the RecyClass guidelines, i.e. involving different actors from the whole packaging value chain, could act as a model for development of similar initiatives in other sectors in a holistic and transparent manner.

In general, having different guidelines for the same products and/or polymers should be avoided.

The development of new guidelines (or the update of existing ones) also needs to address **national specificities**. Such national specificities may include **differences in the collection and sorting processes, recycling rates and targets as well as product-specific requirements**. For example, in the **construction** sector, some countries have legislative technical requirements on the use of recycled PVC in windows whilst others do not. Differences may also exist due to geographical specificities. For example, in the **agricultural** sector, changes in the produced crops have impacts on the amounts and types of plastics used. Fruit cultivation typically requires plastics for greenhouses only during the summer, whereas for vegetables plastics are required all year.

In addition, recently **exports have been limited substantially** due to waste import restrictions imposed by China and Hong Kong combined with some types of plastic being added to the Basel Convention[28]. Nevertheless, significant amounts of plastic waste are still exported, mainly to other Asian countries where there is risk of waste diversion to incineration and landfilling. The development and update of guidelines should **limit the exports of plastic waste to non-EU countries** and enhance their recyclability. This is particularly relevant for WEEE which is characterised by high export and incineration or landfilling rates.

To this end, the development of country-specific methodologies in the guidelines is required. While these specificities should be taken into account, there is also a need for a harmonised approach in the EU, for example in the context of the European Standardisation Organisations Cen and CENELEC.

[28] According to the European Environment Agency (2019), in 2019, around 150 000 tonnes of plastic waste per month were exported from the EU. In 2015 and 2015 the exported amounts were about twice as high as the exports went to China and Hong Kong primarily.

2. Ensure regular updating of the guidelines	
Description	• Provide **regular updates to guidelines**, to integrate future **developments on plastic product design and disruptive recycling technologies**, to also influence design to ensure high levels of recyclability • Develop **guidelines for products where they are currently lacking** (e.g. agricultural plastics) as well as specific applications (e.g. packaging of cosmetics and detergents)
Actors involved	Regular updating of guidelines needs to be carried out by the **issuing bodies** through regular **communication with the whole value chain**. Communication needs to be enhanced in particular with **regulators** (at both the EU and national levels), **recycling technology developers** (mechanical but also disruptive technologies) and **end users** to capture changes on product requirements.
Timeframe	3 years

According to information provided by CPA Design Coordinators and signatories in the context of this study, guidelines are regularly updated in all sectors. Improvements can be achieved in relation to both the **development of guidelines for additional products** and the **integration of innovative approaches**. While guidelines focus on design of products to enhance the performance of mechanical recycling, their compatibility with innovation across the whole value chain could also be improved. Depending on the technical developments and uptake of disruptive technologies in the forthcoming years, the integration of disruptive technologies in the guidelines may be relevant particularly in relation to certain applications that cannot be achieved with mechanical recycling (e.g. clear plastic films in agriculture).

To this end the development of guidelines could follow a **dynamic and future-proof system-based approach** in relation to recyclability of plastics, allowing for the integration of feedstock and chemical recycling. Guidelines also need to be updated to address any **developments in sorting and collecting mechanisms** as well as **changes in structure in specific plastics sectors.**

Regular updates are also required **in relation to existing and prospective EU and national legislation**. This is particularly relevant for the regularly updated List of Substances of Very High Concern (SVHC) imposed by REACH. For example, at the time of drafting of this report, new restrictions were being discussed on PVC that is contaminated with lead.

3. Enhance the consistency and clarity of guidelines	
Description	• Ensure, and improve, the **consistency and precision** of guidelines by also improving the comprehensiveness of **technical specifications**, and integrating **polymer and product-specific criteria** Consider **eco-design** elements in products • Ensure that **product design R&D** focuses not only on the functionality of products but also their recyclability, by integrating a more **comprehensive testing approach** and robust scientific methods • Ensure **coherence with other initiatives and regulatory requirements**
Actors involved	Efforts for improved consistency and clarity should be implemented through joint efforts of **all actors of the value chain and across the EU**. Most importantly, enhanced communication between the organisations involved in the development of the guidelines and product designers and recyclers is required in order to integrate all general, and product and polymer specific criteria to enhance both the **recyclability of products** and the **penetration of recycled materials in the manufacturing** of new products.
Timeframe	3 years

According to some CPA Design Coordinators and signatories, increased recyclability may lead to a decreased functionality of products. To ensure a level playing field it will be necessary to set **common recyclability standards or requirements in all Member States**. This would lift internal market disruptions such as the different national requirements that currently exist in relation to the recyclability of PVC used in windows in

the **construction** sector and the differences in the technical requirements on **agricultural** films, imposed by national and geographical specificities.

Again, a harmonised approach is required at the EU level, in the context of CEN-CENELEC, to **enhance consistency in the application of guidelines across the EU.** In this context, the CPA can contribute to the development or updating of CEN-CENELEC and industry standards on recyclability to enhance a uniform approach. In addition, **the traceability of plastic materials** throughout the entire value chain can be enhanced through a wider application of existing schemes (e.g. the European Certification of Plastics Recyclers, EuCertPlast) to improve the quality of recycled content in end products.

4. Enhance the testing process to demonstrate compliance with the guidelines	
Description	• Develop and provide **simple, and free, self-assessment tools** • Develop **assessment protocols in all sectors and for a wide range of products**, to enhance transparency, precision and consistency regarding criteria applied in recyclability assessments • Ensure that **product design R&D** focuses not only on the functionality of products but also their recyclability • **Reduce the financial burden imposed by the costs of lab testing and auditing** by considering whether products are certified in the design EPR fees, and/or by providing free self-assessment tools
Actors involved	An improvement to the testing processes to demonstrate compliance could be achieved through an **EU-wide independent body comprised of organisations involved in the development of guidelines**. The involvement of **product designers** in this process is important to ensure clarity and functionality of the assessment protocols. Such a body would also ensure that there are no impacts in relation to the competition between the different bodies, particularly in relation to the provision of free self-assessment tools.
Timeframe	3 years

Test protocols can be classified into **two different types of certification**. The first focuses on **design-for-recycling (recyclability)**, which in general is not dependent on national specificities, as it relies on data from defined state-of-the-art sorting and reprocessing units in Europe. The second type focuses on **recycling rates** and is dependent on national characteristics, such as specific national targets, and the overall organisation of the waste management system, including the structure and coverage of EPR schemes.

Such test protocols exist for several products, particularly in the packaging sector. For example, Plastic Recyclers Europe provides free recyclate characterisation guidance for different polymers (HDPE, LDPE, PET, PP, PS and PVC) for different products (e.g. flakes and pellets). These guideline requirements serve as a **basis for the assessment of recycled material quality**, in accordance with best practices, as well as existing European and international standards. Producers can compare their products or groups of products, based on these guidelines. Different publicly available protocols can be developed to cover a higher number of sectors and products. The development of such free self-assessment tools may also decrease the costs incurred for lab testing and audit.

5. Promote the guidelines along the value chains	
Description	• **Enhance communication throughout the whole value chain** (manufacturers, retailers, standardisation organisations, EPR schemes, recyclers and recycling technology developers) to increase the uptake of guidelines • Contribute towards the development of an eventual **EU-wide label** for products that meet the requirements of (specified) guidelines
Actors involved	An increased uptake of guidelines can be encouraged through different activities developed by the CPA. Cooperation is required with different **actors throughout the value chain** in particular **EPR schemes** (to reduce the financial burden through the reduction of fees for certified products) and **retailers** (for the setting of procurement standards).
Timeframe	5 years

A good work plan requires **coordination and crosslinks between the plastics-using market sectors across the whole value chain**. As already stipulated in the draft CPA Declaration, there is a need for the CPA to participate in information and awareness raising campaigns and to work with all actors on an effective framework for separate collection of all plastic waste. This would increase the attractiveness of applying the guidelines from an economic perspective. In the longer term, the CPA can contribute to the translation of design guidelines agreed by the CPA into CEN and industry standards applicable to the fabrication of all new products.

As highlighted in the CPA Declaration, the communication could also address topics that move beyond the uptake of guidelines. This could include the development of new recycling technologies, improved collection and sorting infrastructure and practices, and other aspects that influence the parameters of the supply and demand for plastic recyclates that **affect product design and thus the development of guidelines**.

In relation to an **EU-wide label** to demonstrate compliance with specific guidelines and to further promote the uptake of guidelines, such a common label could be developed to increase the level of recognition by the whole value chain. This could be achieved through the development of a certification in the form of a text that could be awarded to relevant products.

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List of abbreviations and definitions

ABS	Acrylonitrile Butadiene Styrene
ASR	Automotive shredder residue
CEFLEX	Collaborative initiative of a European consortium of companies representing the whole flexible packaging value chain
CEN	European Committee for Standardization
CENELEC	European Committee for Electrotechnical Standardization
COTREP	Comité Technique pour le Recyclage des Emballages Plastiques (France)
CPA	Circular Plastics Alliance
D4ACE	Design for A Circular Economy Guidelines for flexible packaging (CEFLEX)
DfR	Design-for-recycling
EEE	Electrical and electronic equipment
EFBW	European Federation of Bottled Water
ELV	End-of-life vehicles
EPBP	European PET Bottle Platform initiative
EPP	Expanded polypropylene
EPR	Extended producer responsibility
EPRO	European Association of Plastics Recycling and Recovery Organisations
EPS	Expanded polystyrene
EU	European Union
EuCertPlast	European Certification of Plastics Recyclers
EuPR	European Plastics Recyclers
EUR	Euro (currency)
EXPRA	Extended Producer Responsibility Alliance
HDPE	High-density polyethylene
JRC	Joint Research Centre, European Commission
LDPE	Low-density polyethylene
PA	Polyamide
PE	Polyethylene
PET	Polyethylene terephthalate
PO	Polyolefin
PP	Polypropylene
PPWD	Packaging and Packaging Waste Directive
PRE	Plastics Recyclers Europe
PS	Polystyrene
PTT	Post-treatment technologies
PUR	Polyurethane
PVC	Polyvinyl chloride
PVDC	Polyvinylidene dichloride

QR-code	Quick Response-code
RECOUP	Recycling of Used Plastics Limited
rPET	Recycled PET
SVHC	Substances of Very High Concern
UNESDA	Union of European Beverages Association
US	United States
WEEE	Waste electrical and electronic equipment
ZSVR	German Central Packaging Register

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2. Sankey diagram
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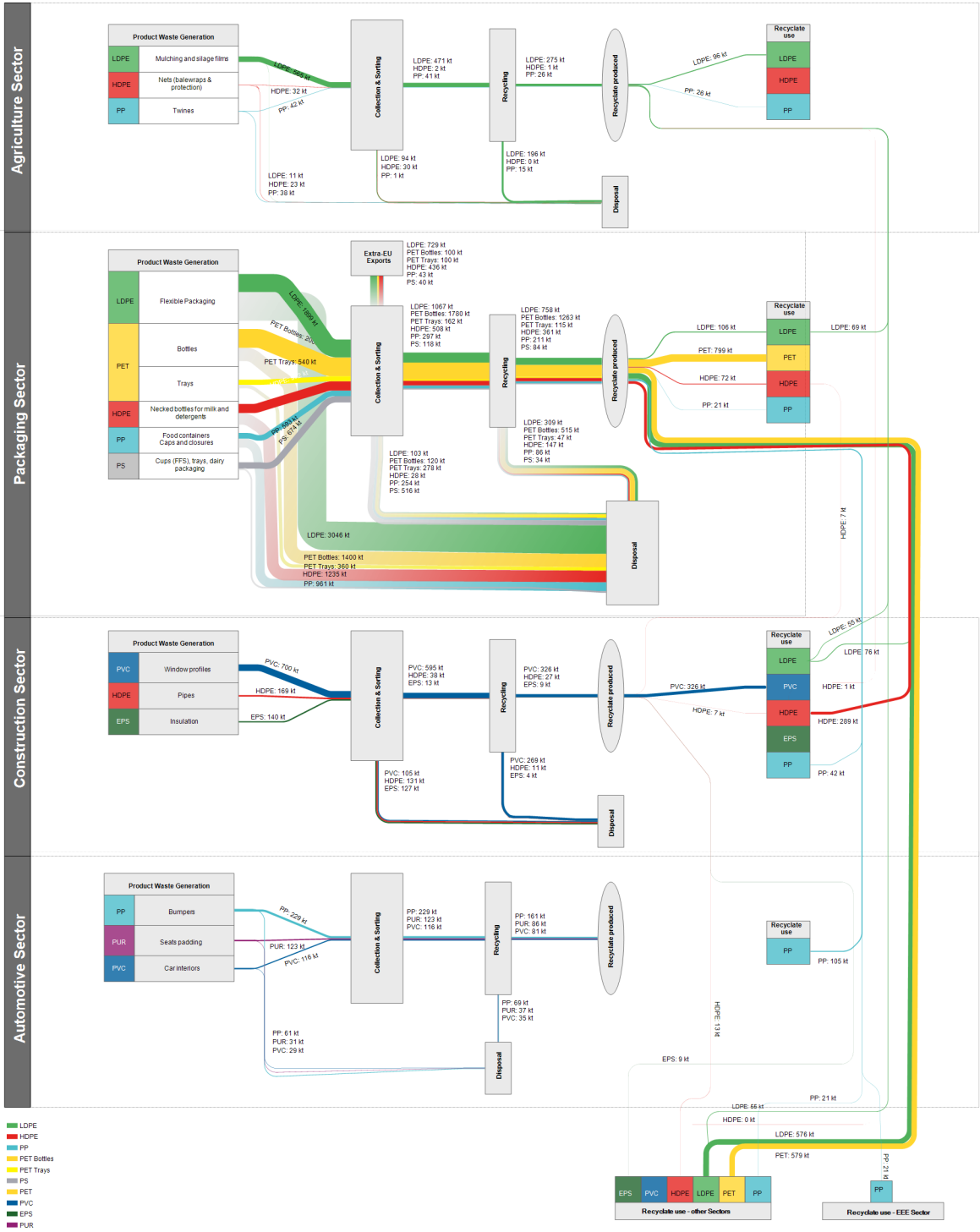
5. List of organisations contacted during the study

Annex 1. Mass flow model

Provided as a separate document

Annex 2. Sankey diagram

Plastic Material Flows - current status



Annex 3. Shortlist of 25 guidelines and longlist of mapped guidelines, standards and tools

Provided as a separate document

Annex 4. Questionnaire to issuing bodies of guidelines

Evaluation Criteria	Evaluation Questions
Effectiveness	What progress has been made in implementing the Guideline and to what extent have the objectives been achieved?
	What has been the uptake of the Guideline (e.g. number of participants, volume of products/ polymers designed based on the guideline, market share)?
	What have been the (quantitative) impacts on recycling rates and to what extent can these be credited to the Guideline?
	We are interested in the factors/barriers that have influenced the uptake, recyclability and recycling rates and to what extent. a. In your opinion, what are the key factors and features of the Guideline that are the most influential to its success (i.e. enabling the uptake, increased recyclability and recycling rates)? b. What are the main challenges and barriers to implementing the Guideline and to achieving greater uptake, increased recyclability and recycling rates?
Efficiency	What are the costs of implementing the Guideline, distinguishing between: ● Membership fees ● Certification fees ● Testing costs ● Compliance costs (e.g. Euro/tonne to comply with technical requirements of the Guideline) ● Any other costs
Good practices and drivers	In your opinion, what external factors have significantly affected recycling rates and quality of recyclates covered by the Guideline and how?
	What has been the impact on recycling rates for recyclates covered by the Guideline?
	In your opinion, what are the main barriers to achieving greater uptake, increased recyclability and recycling rates?
	In your opinion, what can be done and by whom, to increase the recycling rates, the recyclability, and the quality and uptake of recyclates? What levels are achievable?
Coherence	To what extent does the Guideline fit within existing regulatory requirements?
	Does it support the implementation of legislative requirements or other initiatives? Is it supported or hindered by other legislation / initiative(s)?

Annex 5. List of organisations contacted during the study

The study team held multiple contacts/discussions during the study with the Design Coordinators of the CPA's sectoral working groups on Construction, Packaging, Agriculture, Automotive and Electrical and Electronic Equipment (EEE) (see table below).

CPA working group	Name of Design Coordinator	Organisation / affiliation
Agriculture	Xavier FERRY (and previously Bernard LE MOINE)	Agriculture Plastic Environment
Automotive	Chaim WAIBEL	Plastics Recyclers Europe
Construction	Gerald FEIGENBUTZ	European PVC Window Profile and related Building Products Association (EPPA-Profiles)
EEE	Akseli KOSKELA	Technology Industries of Finland
Packaging	Eugenio LONGO	Borealis

In addition, the CPA signatories were invited to attend the final webinar for the study, held on 27 May 2020, and to provide their feedback on the interim report. This feedback was taken into account by the study team during preparation of the final report.

The organisations listed below were contacted specifically to respond to the questionnaire included in Annex 4. Only those marked with * had provided a response to the email questionnaire by the final cut-off date of 19 June 2020.

- Borealis*
- CEFLEX*
- Circular Analytics*
- Citeo (France)
- COTREP (Comité Technique pour le Recyclage des Emballages Plastiques), France*
- Der Grüne Punkt*
- Eco-systemes (France)
- EFBW (European Federation of Bottled Waters)
- European Association of Plastics Recycling and Recovery Organisations (EPRO)*
- European Plastics Recyclers (EuPR)
- EXPRA's Sustainability and Packaging Working Group*
- FH Campus Wien; Section of Packaging and Resource Management*
- IK Industrievereinigung Kunststoffverpackungen e.V. (German Association for Plastics Packaging and Films)
- Institute cyclos-HTTP
- Network for Circular Plastic Packaging (on behalf of the Danish Plastics Federation)*
- PET Containers Recycling Europe (Petcore)*
- RecyClass / Plastics Recyclers Europe (PRE)*
- Recycling of Used Plastics Limited (RECOUP)*
- SUEZ
- UNESDA (Union of European Beverages Associations)*

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